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STUDIES ON EARLY LEPROSY IN CHILDREN OF LEPERS

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THREE PLATES AND ONE TEXT FIGURE

I. INCIDENCE OF LEPROSY IN CHILDREN BORN OF LEPERS AT CULION

Leprosy has been handed down to us from ancient times as one of the most puzzling diseases known to science. Present-day knowledge concerning some of the most important features of this malady is still unsatisfactory. The incubation period, for instance, until very recently, was practically unknown, although the literature is cluttered with innumerable estimates that range from a few months to thirty or more years. What is certain concerning the methods of invasion and the portal of entry is likewise meager, and the question of the initial lesion is still sub judice. This condition of affairs is due to several factors, the most important of which are: (1) The incubation period is long and the development of the disease slow, compared with other infectious diseases; (2) it has not been possible so far to transmit the disease to experimental animals; and (3) it has heretofore been difficult to gather observations on a sufficiently large number of cases, showing the early symptoms of leprosy, to permit definite conclusions being drawn.

The children born at Culion of leper parents, some of whom have become lepers, offer an unusual opportunity for the study of the earliest manifestations of the disease. All of them have lived with their leprous parents for varying lengths of time, the majority continuously since birth.

An article by Gomez, Avellana Basa, and Nicolas, based on a study of three hundred eight of these children, created consid-

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erable interest on account of the unusually rich material presented. The present work, besides bringing their data up to date, takes up in addition certain details, which may not be lacking in interest on account of their direct bearing on the important problem stated above. It is well to state beforehand, however, that the findings should not be applied without reservation to leprosy as it appears in adults.

PRESENT STUDY

Since the establishment of the colony, in May, 1906, to December 31, 1924, eight hundred seventy-one children have been born at Culion, of whom three hundred ninety-eight have died, seventy-five have been sent away as nonlepers, and three hundred ninety-eight were still at Culion at the close of 1924. The data here presented were obtained from a survey of the children remaining at Culion by the end of 1924, as well as from the individual charts of both the children and their parents, from the records in the office of the chief of the Culion Leper Colony and the Negative Children's Home, and from personal interviews with the parents, if alive. Each child was thoroughly examined for suspicious manifestations, and smears from all suspicious blemishes were examined. Most of the bacteriological examinations done in connection with the present work were performed by Dr. F. Solis, of the pathological section of the colony.

Classification.—In their survey, Gomez, Avellana Basa, and Nicolas adopted the following classification of the Culion children:

Positive or confirmed lepers.—These show definite signs of leprosy such as macules, infiltrations, nodules, anæsthesia, etc., and the presence of *Mycobacterium leprae* is demonstrated either from the lesions themselves or from the nasal septum.

Clinical lepers.—This group includes those showing definite anæsthesia or multiple macular lesions and presenting palpable lymphatic glands, but in whom smears taken from the suspected lesions and from the septum are consistently negative for the specific organism.

Suspicious lepers.—These show suspicious manifestations, which usually consist of one or more macules differing in character and distribution from the common *Tinea alba,* and exhibiting doubtful anæsthetic changes. Another relatively common suspicious sign in the younger children is dryness and flushing of the skin at the pretibial region. One or both ulnar nerves are sometimes enlarged.

Nonlepers or negatives.—Children are so classified when entirely free from all suspicious manifestations of leprosy.

For the purposes of description the above classification has been followed in this report. It is my observation, however, that in several cases the suspicious macules are changeable and evanescent, so that a case classified at the first examination as suspicious may be found on reëxamination a few months later to have become negative, even without treatment. For example, of the fifty-eight cases classified as "suspicious" by Gomez, Avellana Basa, and Nicolas in 1922, twenty-four, or 41 per cent, had become negative by December 31, 1924, in spite of the fact that most of them had received no treatment whatever; only a few had treatment for two months. Fourteen (24 per cent) had become lepers, five (9 per cent) were found to be clinical lepers, fourteen (24 per cent) were still suspicious, and one (2 per cent) had died. Of the two hundred six cases found negative by the previous workers one hundred ninety-six were living; eighteen (9 per cent) of these, were clinical and bacteriological lepers, seventy (36 per cent) had become suspicious, and only ninety-nine (50 per cent) had remained negative.

Incidence.—The first survey of the children born at Culion was made by Denney in 1916, ten years after the establishment of the colony. At that time three hundred fifty-one babies had been born, of whom one hundred sixty had died, thirty-seven had been released at early ages, and one hundred fifty-four were still in the colony. He found sixteen of the latter (10 per cent) positive lepers.

At the examination made by Gomez, Avellana Basa, and Nicolas five years later, 7.8 per cent of the three hundred eight children then living were positive lepers, 6.4 per cent were clinical lepers, 18.8 per cent showed suspicious signs, and 66.8 per cent were nonlepers.

Of the three hundred ninety-eight children remaining in the colony by December 31, 1924, fifty-nine (14.8 per cent) were or had been positive lepers, eleven (2.8 per cent) were clinical lepers, ninety-seven (24.4 per cent) were suspicious, and the rest, two hundred thirty-one (58 per cent), were negative. In other words, 42 per cent were either lepers or had suspicious signs of leprosy.

Incidence of leprosy as to age and sex.—Table 1 gives the incidence of positive lepers, clinical lepers, and suspected lepers, according to age, in two-year periods, and sex.

TABLE 1.—*Incidence of leprosy as to age and sex.*

Age group.	Sex.	Positive lepers.		Clinical lepers.		Suspicious.		Negative.		Total.
		Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	
Years.										
0 to 2	Male	1	1.7	0	0	3	5.3	52	93.0	56
	Female	1	2.4	0	0	4	9.8	36	87.8	41
2 to 4	Male	3	10.3	0	0	9	31.0	17	58.6	29
	Female	2	6.2	1	3.1	18	56.3	11	34.4	32
4 to 6	Male	3	8.6	0	0	15	42.8	17	48.5	35
	Female	5	17.2	2	6.9	11	38.0	11	38.0	29
6 to 8	Male	9	29.0	0	0	10	32.2	12	38.6	31
	Female	8	21.6	4	10.8	5	13.5	20	54.0	37
8 to 10	Male	6	25.0	1	4.3	7	29.1	10	41.6	24
	Female	4	12.9	1	3.2	8	25.8	18	58.0	31
10 to 12	Male	5	33.3	1	6.7	1	6.7	8	53.3	15
	Female	2	13.4	0	0	5	33.0	8	53.3	15
12 to 14	Male	3	42.8	1	14.3	0	0	3	42.8	7
	Female	4	50.0	0	0	0	0	4	50.0	8
14 to 16	Male	0	0	0	0	0	0	1	10.0	1
	Female	3	42.8	0	0	1	14.3	3	42.8	7
Total	Male	30	15.1	3	1.5	45	22.8	120	60.6	198
	Female	29	14.5	8	4.0	52	26.0	111	55.5	200

The sexes are about evenly represented, there being one hundred ninety-eight males and two hundred females. Thirty (15.1 per cent) of the males were confirmed lepers, while twenty-nine (14.8 per cent) of the females were found leprous. It is evident that the higher incidence of leprosy among adult males in the proportion of two to one over the females in Culion lepers is not apparent among these children.

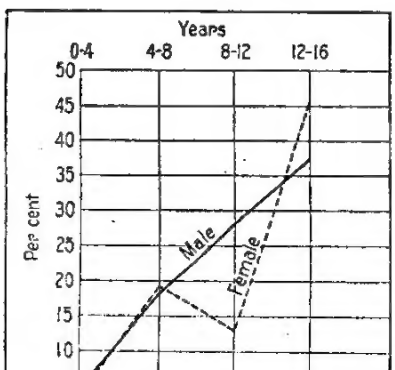

FIG. 1. Incidence of leprosy in male and in female children.

Although considerable differences are noted in some of the age groups there is no tendency for the incidence to vary in either sex from the youngest to the oldest children. If, however, the data shown in Table 1 are condensed and plotted, as in fig. 1, interesting differences between the two sexes will be noted among the older children.

The curve for males in fig. 1 shows a gradual rise with age; the female line, on the other hand, is more irregular. The incidence of leprosy is practically identical in both sexes up to the eighth year; after that age the incidence tends to follow the normal ratio between males and females in adults; namely, two to one (28 to 13 per cent in the 8-to-12-year age group). This is probably due to the fact that dissimilarity between the activities and habits of the girls and those of the boys begins to become pronounced at this period. Between the ages of 10 and 16 years, however, the influences of puberty, naturally more pronounced in girls, become manifest. The incidence among the females rises suddenly, exceeding the male figure by 10 per cent.

Rearranging the data shown in Table 1 so that the age is given in four-year periods, irrespective of the sex, Table 2 was obtained:

TABLE 2.—*Incidence of leprosy according to age, in four-year periods.*

Age.	Number in group.	Positive lepers.	
		Cases.	Per cent.
Years.			
0 to 4	158	7	4.4
4 to 8	132	25	19.0
8 to 12	85	17	20.0
12 to 16	23	10	43.5
Total	398	59	14.8

The incidence is found to increase with age. Only 4.4 per cent of the children below 4 years of age were found leprous, while among the twenty-three remaining children, between 12 and 16 years old, 43.5 per cent were already confirmed lepers. These findings are in line with the observation of Hollmann,[1] who found that, in the case of the children of lepers at the Molokai Settlement, the longer the exposure of the children to their leprous parents the higher the incidence of leprosy, a condition entirely to be expected.

Age at appearance of leprosy.—Table 3 shows the age at which the first suspicious lesions in the clinically positive and the suspicious cases appeared.

[1] U. S. Public Health Bull. 39 (1910).

TABLE 3.—*Age of appearance of suspicious lesion.*

Age at onset.	Clinical lepers.		Suspicious.	
	Cases.	Per cent.	Cases.	Per cent.
Years.				
0 to 1	1	9.1	10	10.3
1 to 2	0	0	10	10.3
2 to 3	0	0	12	12.4
3 to 4	2	18.2	14	14.4
4 to 5	2	18.2	8	8.2
5 to 6	1	9.1	8	8.2
6 to 7	2	18.2	6	6.2
7 to 8	1	9.1	3	3.1
8 to 9	0	0	4	4.1
9 to 10	0	0	4	4.1
10 to 11	0	0	0	0
11 to 12	0	0	0	0
12 to 13	0	0	1	1.0
No data	2	18.2	17	17 5

In 33 per cent of the suspicious children, the first suspicious lesion was noticed during the first three years. Among the clinically positive cases only 9.1 per cent showed the first lesion during this period; in 45 per cent it was observed between the third and the sixth years.

The ages at which the lesions were found bacteriologically positive in the group of confirmed lepers are given in Table 4.

TABLE 4.—*Age of children when found positive bacteriologically.*

Age.	Positive lepers.		Age.	Positive lepers.	
	Cases.	Per cent.		Cases.	Per cent.
Years.			*Years.*		
0 to 1	0	0	7 to 8	1	1.7
1 to 2	2	3.4	8 to 9	2	3.4
2 to 3	8	13.5	9 to 10	4	6.8
3 to 4	9	15.3	10 to 11	1	1.7
4 to 5	10	16.9	11 to 12	2	3.4
5 to 6	11	18.6	12 to 13	1	1.7
6 to 7	7	11.9	No data	1	1.7

Fifty per cent of the confirmed lepers were found positive between the ages of 3 and 6 years. The average age at which the confirmed lepers became bacteriologically positive was 5 years 9 months. There is no doubt that in many of these cases the lesions were actually positive for some time before the bacteriological examinations were made. Taking also the period

of incubation into consideration it is evident that infection had taken place at a very early age. This matter will be discussed more fully later.

In fifteen cases it has been possible to make repeated bacteriological examinations from the initial suspicious lesions until they became positive. In two children the first lesion was found positive within a week after it was noticed. The longest period observed in the others was thirteen months; the average was five months.

The youngest leper seen was a girl who was found bacteriologically positive at the age of 18 months. The initial macular lesion was first seen at the age of 8 months, and repeated bacteriological examinations from it were negative until ten months later. The next youngest was also a girl, 22 months old, on whom the initial lesion was first noticed five months before becoming positive microscopically.

CONCLUSIONS

1. Of the three hundred ninety-eight children of leprous parents living in the Culion Leper Colony on December 31, 1924, fifty-nine (14.8 per cent) were bacteriologically positive, or had been positive lepers; eleven (2.8 per cent) were clinical lepers but negative bacteriologically; ninety-seven (24.4 per cent) had suspicious manifestations, and two hundred thirty-one (58 per cent) were nonleprous.

2. The incidence of leprosy among these children increased with the length of the period of exposure; both sexes were about equally affected at the same age.

3. Fifty per cent of the confirmed lepers became positive between the ages of 3 and 6 years, the average age at the time they were found positive being 5 years 9 months.

II. FACTORS INFLUENCING TRANSMISSION DURING INTRAUTERINE LIFE

Heredity.—The discovery of the specific organism by Hansen in 1874 has definitely thrown into the discard the theory of hereditary transmission of leprosy. In the strict biological sense, a bacterial or parasitic disease cannot be so transmitted. However, several of the older authorities, among them Virchow, Van Dyke, and Carter and Levering[2] have claimed that, as is

[2] All cited in the Report of the Leprosy Commission to India, Calcutta. Government of India General Printing Office (1892) 224–225.

believed by some to be the case in tuberculosis, a predisposition to leprosy may be passed on by leprous progenitors to their offspring. This belief is based on the assumption that some organs or tissues of the body lack powers of resistance to the particular disease and that the defect is transmitted by heredity. A few writers have presented a large mass of data purporting to support this view, but their conclusions are largely negatived by the fact that the possibility of contagion cannot be eliminated in their cases.

As leprosy is present in either one or both of the parents of the children here reported, it is natural to presume that a taint in direct line exists in every case. It has been pointed out by Leloir however that, if the family taint is to be considered as a legitimate etiological factor in the transmission of a disease or its predisposition, it is necessary to ascertain whether the parent or parents were in a diseased condition at the time the child was born. For this reason, two children, born before the parents of either had developed leprosy, have been excluded in the following discussion. Outside of these two exceptions, one, or more frequently both, of the parents were leprous at the time of the birth of the child.

In order to determine the possible influence of a strongly positive history of leprosy in the family of the parents on the incidence of leprosy among their offspring, data on this point have been obtained, which are shown in Table 5. In the majority of the cases it was possible to trace the occurrence of the disease back to the parents' grandparents, so that four generations are included. The element of contagion may be disregarded in this connection, as all of these children have been exposed to the disease.

TABLE 5.—*Incidence of leprosy in relation to the existence of a positive history of leprosy in the parents.*[a]

History of leprosy in parents.	Cases.	Condition of offspring.							
		Lepers.		Clinical lepers.		Suspicious.		Negative.	
		Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Negative	84	11	13.1	1	1.2	31	36.9	41	48.9
Taint in direct line	102	12	11.8	5	4.9	28	27.4	57	55.9
Taint in collateral line	99	14	14.1	2	2.0	37	37.4	46	46.5

[a] The diagnoses of leprosy reported in the family are in the large majority of our cases accurate, as most of the cases have been admitted to the Culion Leper Colony.

From Table 5 it would seem that the existence of a positive family history in either one or both of the parents does not necessarily favor the development of leprosy among their offspring. In other words, no greater predisposition to leprosy was observed among children of persons coming from families with distinct history of leprosy than among children of parents without a taint in their family. Twelve per cent of the children of lepers with distinct family taint have become leprous, while 13 per cent of those neither of whose parents had leper ancestors or relatives were found positive.

Taking the fathers and the mothers separately, however, an interesting difference is brought out, as can be seen in Table 6. The suspicious and negative cases have been omitted.

TABLE 6.—*Incidence of leprosy among Culion children in relation to the family history of the father and the mother.*[a]

Family history.	Cases.		Confirmed and clinical lepers among the children.	
	Number.	Per cent.	Number.	Per cent.
Father:				
Negative for leprosy	175	68.5	29	16.5
Taint in direct line	39	15.3	4	10.2
Taint in collateral line	41	16.1	6	14.6
Mother:				
Negative for leprosy	115	42.8	13	11.3
Taint in direct line	77	28.7	16	20.8
Taint in collateral line	76	28.4	14	18.4

[a] Data on thirteen fathers who were nonlepers could not be obtained.

With reference to the fathers, 16.5 per cent of the children of those with negative family history have become lepers, while only 10.2 per cent of the children of fathers with family taint in direct line were leprous. On the other hand, the incidence of leprosy in the children of mothers with leprous family taint is considerably higher than among those who did not show a taint (20.8 per cent and 11.3 per cent, respectively).

It is also to be noted that, while only 15.3 per cent of the fathers show a family taint in direct line and 16.1 per cent in collateral lines, the corresponding figures for the mothers are 28.7 and 28.4 per cent, respectively. It would seem then that the transmission of a predisposition, if it exists at all, is stronger in the female than in the male. This observation is further strengthened by the finding that, of the thirty-nine female children of mothers showing taint in direct line, 30.8 per cent

had become confirmed and clinical lepers, whereas only 13.1 per cent of the thirty-eight male children of the same mothers were found to be leprous. On the other hand, of fifty-eight female children of mothers with negative family histories, only 12 per cent were found leprous, whereas 18.6 per cent of the male children had leprosy. It is of interest to note that the Leprosy Commission to India [3] obtained an incidence of only 4 per cent of family taint in direct line, and accepted Van Dyke's figure of 14.5 per cent in collateral lines among Indian lepers.

Summarizing, it may be stated that the data given above neither prove nor disprove conclusively the possibility of transmission of a predisposition. I believe that the statement of Fishberg [4] with regard to the same problem in tuberculosis can be applied as well, mutatis mutandis, to leprosy. This author says:

> Statistical proof of the hereditary transmission of tuberculosis, or a predisposition to it, will only be satisfactory when careful records of many patients are kept for several generations in which children of tuberculous parentage have succumbed to the disease despite the fact that they have been removed immediately after birth. To be of scientific value they should be based on detailed postmortem examinations of parents and grandparents, and even of collaterals. Such data we do not have.

However, we are justified in stating that, if transmission of a predisposition is possible at all, it plays a minor rôle in the dissemination of leprosy.

Placental transmission.—Transmission through intrauvular and spermatogenic infection is of no practical importance, and this possibility may be disregarded. It is a well-known fact, however, that many diseases, such as smallpox, syphilis, etc., may be transmitted from the mother during pregnancy to the fœtus through the placental circulation. In view of the frequent finding of lepra bacilli in the blood of lepers, this possibility has to be considered.

With regard to the literature on this very interesting subject only the abstracts of two articles are available to me. Sugai and Monobe,[5] besides finding the bacilli in four out of twelve placentas of leper mothers and lepra cells in six others, were

[3] Report of the Leprosy Commission to India, Calcutta. Government of India General Printing Office (1892) 224–225.

[4] Pulmonary Tuberculosis. Lea & Febiger, Philadelphia (1924) 103.

[5] Sei-i-kwai Med. Journ. 32 (1913) 102–103. [Orig. Journ. Tok. Med. Assoc. 27 (1913) 8. Abst. Trop. Dis. Bull. 2 (1913) 281–282.]

able to demonstrate the presence of the organism in ten out of twelve newly born babies, and in the blood of a 17-month-old child of an infected mother. D. San Juan [6] has also found acid-fast bacilli in globi form in the placenta of lepers.

In connection with the present work, the placenta and umbilical cord were examined for gross pathological changes and for the presence of *Mycobacterium leprae*. In fifteen specimens examined four (26.6 per cent) were found positive for *M. leprae* in the cord at its fœtal end, twice in globi form; only in one of these were the bacilli found also in a smear taken deep in the placental tissue. This phase of the work has been continued by Dr. E. V. Pineda, of the pathological section, who, using a much improved technic, has been able to obtain positive results with considerably greater frequency.

It is evident that the bacilli reach the fœtus through the placental circulation in a considerable proportion of the cases. This is undoubtedly particularly apt to occur when the mother develops during pregnancy the so-called "lepra fever," a condition which is often accompanied by bacteremia.

In this connection, the following observations seem significant. Of nineteen children of mothers having lepra fever during pregnancy, three (16 per cent) have become lepers, while only five (5 per cent) of one hundred children, of mothers who did not have such exacerbations, developed the disease. A dissimilarity in the size of the two groups exists, but the results are suggestive. Furthermore, the average age at onset in the three positive children of "lepra fever" cases was 2 years 11 months, one year less than the average age at onset in the five leprous children of mothers without lepra fever. As the age at which the disease appeared in these three children is well under the estimated incubation period in children, it is possible that the infection was transmitted through the placental circulation, though no manifestations were apparent at birth.

What finally happens to the bacilli after reaching the fœtal circulation cannot, in the light of our present knowledge, be ascertained. The fact remains that experience in Hawaii [7] and in India [8] has shown that, if the children of lepers are segregated immediately after birth, only a negligible percentage de-

[6] Rev. Argentina de Obst. y Ginecol. 1 (1919). Abst. Rev. de Med. y Farm., Manila 10 (1919) 439.

[7] Hasseltine, U. S. Public Health Bull. 141.

[8] Jackson, In Leper Land. Marshall Brothers, London (1901) 108.

velop the disease. Two possiblilities suggest themselves, as follows:

1. The organism may remain dormant in some organ, such as the lymph nodes, spleen, nerves, etc., to flare up and multiply when for some reason or other the natural resistance of the body fails.

2. The tissues of the fœtus and young infant may, with comparative efficiency, be able to dispose of the organisms so that, though organisms frequently reach them, infection infrequently ensues, as suggested by Dr. H. W. Wade, chief pathologist of the Culion Leper Colony. It is possible that in this manner a certain degree of immunity, lasting for a longer or a shorter time, may be conferred upon the child.

We cannot present any data at present to prove or disprove either of these theories. The fact remains that certain children are more susceptible than others and many apparently remain free from the disease, in spite of the most intimate contact with infective cases.

Congenital leprosy is unquestionably rare. I have not seen a single case among the one hundred sixty newborn children that I have examined so far. Currie [9] reports that in the literature of twenty-five years previous to 1915, only fourteen claims for prenatal infection have been made. I have, however, seen six cases in whom the suspicious lesions appeared between the third and the sixth months. Three of these lesions later became positive bacteriologically between the second and the third years.

Neither was there observed a higher incidence of congenital debility among the Culion children than among children born of Filipino nonleper parents. I believe that, if such a condition has been observed at Culion and other leprosaria in the past, it was due to the poor surroundings and misery suffered by the parents rather than to any effect of the disease per se.

The death rate among children less than 1 year old and the percentage of those dying of congenital debility among the children of leper parentage at Culion have consistently diminished, with the improvement in the care of the lepers in the colony.

Conditions at Culion were so poor in 1906 and 1907 that none of the children born during those years reached the age of 2 years. Of all the children born in the colony since its establishment, in May, 1906, to December 31, 1921, 42 per cent died within the first year after birth. According to Gomez et al.,

[9] Am. Journ. Trop. Dis. & Prev. Med. 3 (1915–1916) 91.

this was about the same as the corresponding rate for the City of Manila during the same period.

With the generalization of the antileprotic treatment and the careful attention given to children born in the colony, made possible by the considerable increase in the medical and nursing staff early in 1922, the infant mortality has shown a marked reduction.

In the period of two years between January, 1922, and December 31, 1923, there were one hundred twenty-eight births of leprous parentage at Culion. Of this number, thirty (23 per cent) died below the age of 1 year. The corresponding figures for the City of Manila, for 1922 and 1923 together, was 19.3 per cent. The difference is not at all marked, considering the difference between the living conditions at Manila and those at Culion.

The above figures disprove the existence of congenital weakness due to leprosy in the parents. The infant mortality among the offspring of lepers diminishes as better care is given to the parents and to the children themselves.

Treatment of mothers during pregnancy.—In two hundred forty-two cases it has been possible to obtain data on the influence of the treatment of the mother, before and during pregnancy, with the chaulmoogra-oil derivatives. Of these, one hundred eighty-four received treatment at the time of conception and during pregnancy, while fifty-eight had none. The incidence of leprosy among their offspring is given in Table 7.

TABLE 7.—*Incidence of leprosy among children of treated and untreated mothers (during pregnancy).*

Care of mother during pregnancy.	Cases.	Lepers.		Clinical lepers.		Suspicious.		Negative.	
		Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Treated	184	27	14.7	7	3.8	37	31.0	93	50.5
Untreated	58	6	10.4	2	3.4	21	36.2	29	50.0

In both groups about 50 per cent of the children have remained free from all traces of the disease so far. Although a proportionately lower percentage of the offspring of the untreated mothers have become lepers, there are relatively more suspicious cases in this group. At any rate, the difference between the two groups is not marked; it is evident that treatment of the mothers with the chaulmoogra derivatives does not diminish the incidence of leprosy in their offspring.

CONCLUSIONS

1. Hereditary transmission of a predisposition to leprosy is difficult to prove. The data presented in the present study indicate that, if such a possibility exists at all, it plays a minor rôle in the spread of the disease.

2. The lepra bacillus present in the tissues of a leprous mother reaches the fœtal circulation in a considerable percentage of cases, but the evidence is conclusive that transmission by this route very rarely takes place.

3. No congenital case of leprosy was seen or reported in the eight hundred seventy-one children born at Culion up to 1924. The earliest suspicious lesions were seen at the age of 3 months.

4. Leprosy in the parents does not give rise per se to an increased incidence of congenital debility in the offspring.

5. Treatment of leper mothers during pregnancy does not diminish the incidence of leprosy among their offspring.

III. FACTORS INFLUENCING TRANSMISSION DURING INFANCY AND EARLY CHILDHOOD

Possibility of transmission through the mother's milk.—The question of the possibility of transmission through the mother's milk needs to be investigated in view of the reported frequent involvement of the breast in lepers. Furthermore, Sugai and Monobe [10] have reported that they found *Mycobacterium leprae* in the milk of leper mothers in two out of ten cases. However, our experience at Culion is at variance with this. In not one of forty-five specimens examined by Doctor Solis was it possible to demonstrate the presence of *M. leprae*. The milk was centrifuged, and smears were taken from the cream as well as from the sediment.

Though most of the children born and brought up at Culion were breast fed, a considerable number have been either entirely bottle fed since birth or have received mixed feeding. Opportunity is thus given for the comparison of the influence of the manner of feeding on the incidence of leprosy among these children.

Of one hundred thirty-eight breast-fed children, 11.6 per cent were found to have become leprous; among sixty-five children who received mixed feeding, 16.9 per cent were lepers, while fully 24 per cent of fifty-four exclusively bottle-fed children were

[10] Abst. Trop. Dis. Bull. 1 (1916) 566.

leprous. The incidence of leprosy among the bottle-fed children is twice that in breast-fed children.

The mother's milk does not therefore seem to be an important vehicle of transmission in leprosy. The breast-fed children were as a rule found in better general condition; bottle feeding as practiced by the mothers at Culion resulted in weak and undernourished children, on the whole. This explains the difference in the incidence of leprosy in the two contrasting groups; the strong and better-nourished breast-fed children were more able to fight off the infection. It is thus once more shown that the better the health of the child exposed to leprosy the less its chance of acquiring the infection.

In my experience as member of the committee which examines the negative candidates in this colony, and in examining the breasts of leprous mothers, my attention has been drawn to a peculiar finding which I have not seen reported in the literature. While involvement of the nipples is quite commonly seen in middle-aged leprous women who have not given birth, it is very rarely found in women of the same age and in the same stage who have become mothers. In other words, most of the leprous women with infiltrated nipples are sterile. Further, involvement of the nipple is more frequently observed in males than in females.

Importance of skin diseases as portals of entry.—Gomez, Avellana Basa, and Nicolas remarked on the frequency of skin diseases in the Culion children. I have endeavored to secure more definite data on this point.

Of three hundred thirty-four children over 1 year of age examined, only twenty-three were definitely known to have had no skin disease of any kind. Of these, four (17.4 per cent) were lepers, one (4.5 per cent) was a clinical leper, five (21.8 per cent) were suspicious, and thirteen (56.5 per cent) were negative.

Of the rest, three hundred eleven in number, seven had had ordinary eczema, one of whom had become a leper; one had had yaws and was a suspicious leper; one hundred seventy-eight had had scabies, twenty-four (13.5 per cent) of whom were lepers. In one hundred twenty-five cases no definite data as to incidence of skin diseases could be obtained.

Although the number of children who had had no skin disease was too small to form an entirely satisfactory basis for comparison with those who had had skin diseases, it would seem that,

contrary to common belief, skin diseases as a whole do not predispose to infection.

If scabies, which was the most frequent skin disease encountered, played an important rôle in the transmission of leprosy, there would not only be a higher incidence of leprosy among children who had had scabies than among the clean children, but comparatively more of those who had had the itch for a longer time would show leprosy.

Table 8 shows the incidence of leprosy among the children who had had scabies, based on the duration of the skin affection.

TABLE 8.—*Relation of duration of scabies to incidence of leprosy.*

Duration of scabies.	Total cases.	Cases becoming lepers.	
		Number.	Per cent.
Months.			
0 to 2	67	10	14.9
2 to 4	60	9	15.0
4 to 6	0	0	0
6 to 8	6	0	0
8 to 10	0	0	0
10 to 12	37	4	10.8
Over 1 year	8	1	12.5

Although the groups are not entirely comparable, due to differences in numbers, it is seen that, while the average incidence up to four months' duration is about 15 per cent, the corresponding figure for ten months upward is only 11 per cent. These figures confirm the preceding observation that scabies does not necessarily predispose to infection with leprosy. As for other skin diseases, we do not possess sufficient data to prove or disprove either side of the question.

However, it should not be concluded that infection cannot take place through a scabies itch. In fact, I have seen three cases in which the portal of entry was very evidently a scabies itch, as the first visible lesion was a macule surrounding an old scabies scar and growing concentrically from it. The macules of two of these cases were later found positive for *Mycobacterium leprae*.

Plate 1, fig. 1, shows the initial lesion of one of the two positive cases. A fresh macule developing from another scabies scar is also to be seen.

One other case was seen in which the first suspicious macule was seen in the middle of a triangular skin area at the back of

the thigh, formed by three scabies scars, about an inch apart. I have not seen a suspicious lesion surrounding an active scabies itch.

The data here presented seem to prove that, although infection undoubtedly takes place with the scabies itch as the portal of entry, this skin disease as a rule does not predispose to infection.

It is not possible to state just how infection takes place through the lesions produced by *Acarus scabiei* when this occurs. Whether the raw surface affords an entrance for the bacilli, or whether the mite itself is responsible for its introduction, remains to be established. Why the presence of scabies does not generally favor infection, as might be expected, is not evident; possibly the inflammatory reaction resulting from the irritation favors the disposal of any bacilli that may gain entrance. Or, if the mite is the transmitting agent, it may not ordinarily carry a sufficient number of the organisms to produce an infection. When the itch is located directly on a recent infiltrated patch rich in bacilli, however, the mites may become the bearers of a sufficiently large number of bacilli to determine an infection in a new host.

Effect of leprosy in the parents.—Sand [11] has reported the most extensive data on this particular subject. He investigated five hundred twelve marriages in which one or both parents were lepers. He found one thousand six hundred fifty-five (93.4 per cent) sound and one hundred seventeen (6.6 per cent) leprous children issuing from these marriages. Lie [12] also investigated four hundred eighty-one marriages. The data of these investigations are here presented in tabular form (Table 9) compared with similar figures obtained at Culion.

TABLE 9.—*Incidence of leprosy in children of nonleper and of leper parents.*

Parents.	Sand.		Lie.		Rodriguez.	
	Marriages.	Incidence of leprosy.	Marriages.	Incidence of leprosy.	Marriages.	Incidence of leprosy.
		Per cent.		*Per cent.*		*Per cent.*
Father leper, mother nonleper	356	4.9		10.27	0	0
Mother leper, father nonleper	138	10.5		16.39	23	14 3
Father and mother both leprous	17	12.7		39.19	245	15.8

[11] Lepra 12 (1911–1912) 39–46.

[12] Dermat. Wochenschrift 66 (1918) 1–14.

It is to be expected that, when the mother is a leper and the father is healthy, the incidence of the disease in the children is larger than when the father alone is infected. In fact, Sand asserts that it is striking that the difference is not twice as great as is actually shown in his cases. We have no data on the children issuing from marriages in which the husband alone had leprosy. In the other two groups, our figures, when the mother alone is a leper (14.3 per cent) and when both parents have the disease (15.8), are comparable with Sand's (10.5 and 12.7 per cent, respectively) and are considerably lower than Lie's (16.39 and 39.19 per cent).

Table 10 shows the influence of the type and advancement of the mothers' leprosy on the incidence of leprosy among their offspring in Culion lepers.

TABLE 10.—*Relation of type and advancement of leprosy in the mother to the incidence of leprosy in the children.*

Type and advancement of leprosy in mothers.	Cases.	Incidence of leprosy in children.	
		Number.	Per cent.
Type:			
Cutaneous	34	12	35.3
Mixed	185	25	13.5
Neural	33	3	9.1
Advancement:			
Slight	52	12	23.1
Moderate	166	20	12.0
Advanced	34	8	23.6

No data were obtained on thirty-six mothers who died previous to the present survey and whose records are missing. The incidence of leprosy is highest (35.3 per cent) among the children in contact with mothers with cutaneous leprosy, which is considered the most contagious type. In the case of mothers with the mixed type 13.5 per cent of the children became lepers, while in the case of those with neural leprosy only 9.1 per cent of the offspring became lepers.

Advancement does not seem to play an important rôle, the different stages being apparently equally infectious.

As regards the fathers, the effect of the type and advancement of the disease is seen in Table 11.

TABLE 11.—*Relation of type and advancement of leprosy in the father to the incidence of leprosy in the offspring.*[a]

Type and advancement of leprosy in fathers.	Cases.	Incidence of leprosy in children.	
		Number.	Per cent.
Type:			
Cutaneous	40	10	25.0
Mixed	136	20	14.7
Neural	32	5	15.6
Advancement:			
Slight	58	12	20.7
Moderate	123	18	14.6
Advanced	27	5	18.5

[a] In thirty-seven cases, the fathers could not be traced. Naturally, the data on the twenty-three nonleprous fathers do not appear in this table.

Although the difference is less marked than in the case of the mothers there is also a higher incidence of leprosy in the offspring of leper fathers with the cutaneous type than in children of fathers with mixed or anæsthetic leprosy.

Table 12 shows Sand's figures on the effects of the type of leprosy in the parents on the incidence of leprosy among their offspring, compared with the corresponding data obtained from Tables 10 and 11.

TABLE 12.—*Influence of type of leprosy in parents on incidence of leprosy in offspring.*

Type of disease.	Incidence of leprosy in children of lepers.		Type of disease.	Incidence of leprosy in children of lepers.	
	Rodriguez.	Sand.		Rodriguez.	Sand.
Mother:	*Per cent.*	*Per cent.*	Father:	*Per cent.*	*Per cent.*
Cutaneous	35.3	13.4	Cutaneous	25.0	6.6
Mixed	13.5	.....	Mixed	14.7	.....
Neural	9.1	5.2	Neural	15.6	1.3

In Sand's, as well as in the Culion cases, there is a higher incidence of leprosy in the offspring of lepers with cutaneous leprosy than among the children of those with the neural type, the difference being especially marked in the case of the mothers. More children among the Culion cases have become lepers under each type than among Sand's cases.

CONCLUSIONS

1. Breast feeding is not an important factor in the transmission of leprosy from mother to child.

2. Although in some cases the itch of scabies undoubtedly serves as the portal of entry in leper children, scabies and other skin diseases do not, in general, predispose to infection with leprosy. I have actually found a higher incidence of leprosy among children who have had no skin disease than among those who have had such disease.

3. As the leper parents, particularly the mothers, are in more intimate contact with their children than is any other person, they are chiefly responsible for infecting their own offspring. When the type of the leprosy in the parents is the neural, fewer children become infected than when it is the more-contagious cutaneous or mixed type.

IV. THE INITIAL LESION

Several writers on leprosy, among them Gomez,[13] believe that an initial primary lesion does not necessarily exist in this disease. Those holding this view contend that in many instances the invading microörganisms produce no appreciable lesion at the point of entrance and that, after having gained a foothold in the body, they may remain latent for a varying length of time. When conditions become propitious for their growth, the microorganisms multiply and the disease manifests itself.

The investigations of Sorel [14] and of Leboeuf,[15] in regard to the presence of acid-fast bacilli in the lymphatic glands of apparently normal individuals who have lived with lepers, serve to confirm this belief. Sorel found the bacilli in an inguinal gland in one out of fifteen persons living in close contact with lepers, while Leboeuf also found one such case out of five individuals cohabiting with lepers. These findings point to the lymphatic glands as the reservoir wherein the bacilli may lie immured during their inactive state in the body.

The above observations are based mostly on experience in adults. Gomez has made a study of the Culion children, but he was undoubtedly more influenced in his final conclusion by his findings among the inmates of the San Lazaro Hospital, who were mostly adults.

[13] Journ. Phil. Is. Med. Assoc. 3 (1923) 227–229.
[14] Bull. Soc. Path. Exot. (1912) 698.
[15] Ibid., 569.

As a result of my own observations among Culion children, I am inclined to believe that a primary lesion was present in the majority of those children (75 per cent) who have become definitely leprous. This belief is based on the following facts:

1. The three cases on whom the first lesion seen was a gradually enlarging macule starting from a scabies scar (mentioned in Part III of the present study) would seem to prove that a scabies itch may be the portal of entry and that a definite primary lesion existed at this site.

2. In seven other cases it has been possible to show that the initial lesion appeared just where a discharging nodule or a much-infiltrated skin on the forearm of the mother came in direct contact with the body of the child when she was carrying it. Incidentally, these seven cases would also seem to indicate that the irritation produced by the scratching of the child is enough so to affect such changes in the skin as to permit the entrance of the invading organisms.

3. The initial lesion was never seen in certain parts of the body that are frequently the sites of leprotic lesions in the more-advanced stages of the disease—such, for example, as the chest and the abdomen. Although certain places of predilection may be expected, such regions would not be entirely free if the first visible lesions were produced by the dissemination of the micro-organisms through the blood and the lymphatic systems.

4. In the cases where an initial lesion was found to have been present, such lesion was the only one seen for a considerable period of time.

It is assumed that from the initial lesion, involvement of the peripheral nerves, the lymph nodes, and the other organs takes places more or less rapidly, so that the infection does not remain localized for long.

Location of the initial lesion.—Gomez, Avellana Basa, and Nicolas,[16] in their study on Culion children, found that the skin, rather than the nasal septum, was frequently the site of the initial lesion. In the twenty-four confirmed lepers found by them, all were positive bacteriologically on the skin; in only thirteen were the bacilli found also in the nasal septum. In not a single case did they find *Mycobacterium leprae* in the nasal septum without a positive lesion on the skin.

In the present survey, it has not been possible to examine the nasal septum in all the cases for *M. leprae*. Ten months

[16] Philip. Journ. Sci. 21 (1922) 233–256.

later bacteriological examination of the nasal septum (combined with similar examinations from all suspicious cutaneous lesions) of two hundred fifty of these children above 3 years of age was made by Solis and Wade.[17] These workers confirmed in the main the findings of Gomez et al. In 60 per cent of the thirty-five children found positive, the bacilli were found on the skin only. They failed to find a case with positive nasal smears in the absence of positive skin lesions. Furthermore, positive smears from the nasal septum were most frequent in the oldest age groups.

Table 13 gives with more detail the location of the initial lesion in forty-four of the fifty-nine positive cases (75 per cent) in whom such lesions were noted.

TABLE 13.—*Location of the initial lesion on the skin.*

Location of the initial lesion.	Number.	Per cent.
Buttocks	17	28.8
Cheeks	7	11.8
Thighs, posterior and lateral surfaces	5	8.5
Loins	4	6.7
Knees	3	5.1
Forearms, lateral and posterior surfaces	3	5.1
Dorsum of hands	2	3.4
Scapular region	1	1.7
Arms, posterior surface	1	1.7
Legs, lateral surface	1	1.7
No initial lesion seen	15	25.4

In 25 per cent of the cases no initial lesion was discovered. It seems very likely that in many of them a primary lesion may have previously existed on the skin but had only been missed or no visible lesions were produced. On the other hand, it is possible that in these cases the portal of entry may not have been the skin and the initial lesion may have been localized elsewhere. The first leprotic manifestations in such cases were a generalized rash, multiple pinkish or pale macules, or anæsthesia without any sign whatever of the skin involvement. Furthermore, in these cases the lesions appeared all over the body including the chest and abdomen, which regions were never found to be the sites of the initial lesion. Plate 2, fig. 1, shows a child 3 years 6 months old, with generalized pink macules, on whom no initial lesion was seen.

[17] Bacteriological findings in children of lepers with special reference to the nasal septum. (In press.)

As to the location of the initial lesion, the striking feature is the limiting of the lesion to the posterior and posterolateral surfaces of the trunk and extremities, and to the cheeks. In the confirmed-leper, clinical-leper, and suspicious groups, representing in all one hundred sixty-seven cases, I have not seen a suspected primary lesion on the chest and abdomen, on the inner surfaces of the extremities, or on the genitals.

Knowledge of local customs as to the care of children is necessary to appreciate the data given above. The children are only scantily clad on account of the warm climate; trousers are not usually worn until the third or even the sixth year. Thus, the more or less exposed body of the child comes in direct and intimate contact with the mother, or with such infected objects as chairs, the floor, mats, the ground, etc.

There is another possibility which is believed worth considering. The characteristic location of the first lesions observed in the positive children suggests the possibility of the bedbug as the transmitting agent. The sites indicated in Table 13, including the cheeks, are just the places most liable to be bitten by bedbugs when the child is sleeping or sitting. Of course, it need hardly be mentioned that a large amount of investigation has already been done in connection with bedbugs, with inconclusive results. Acid-fast organisms, considered to be lepra bacilli, have been found in 10 per cent of three hundred two bedbugs fed on lepers, as reported by various workers, and 1 per cent of five hundred sixty-six specimens caught from lepers' quarters. The bacilli were never found in numbers that would suggest multiplication of the organism in the insect.

Nature of the initial lesion.—The commonest and most characteristic lesion is the pale pigmented macule already fully described by Gomez et al. The macules are usually irregular, pale or fawn-colored areas, not elevated but often with fairly distinct borders, presenting an even surface free from scales and varying in size from that of a rice grain to extensive areas covering the larger portion of an extremity or the back.

These areas show some impairment, however slight, of one or more of the elements of the cutaneous senses. The thermal and the pain sensations are frequently involved first, although there is seldom complete loss of sensibility. In older patches sweat is diminished or absent over the spot, and the hair is scanty or entirely missing.

The macules usually increase slowly in size, but they may gradually fade and disappear, even without treatment. The presence of a pinkish tinge at the borders or at the center indicates that the lesion is active and such areas are generally positive for *Mycobacterium leprae*. Plate 1, fig. 2; Plate 2, figs. 1 and 2; and Plate 3 show the general characteristics and the development of these macules. Less frequently seen are the pinkish macules appearing as such from the very start. Anæsthesia is seldom found to be an early manifestation in the Culion children, perhaps on account of the impossibility of eliciting it in many of them, for obvious reasons. Flushing of the skin at the pretibial regions is frequently associated with the pale areas, in children below 2 years of age. After some months the skin becomes dry and glistening, and later it becomes scaly. Occasionally it may be the only manifestation seen, preceding the multiple macules by several months.

The relative frequency of the different initial lesions or manifestations in the confirmed, clinically positive, and suspicious cases is given in Table 14.

TABLE 14.—*Relative frequency of different lesions or complaints that were first observed in confirmed, clinically positive, and suspicious cases.*

Initial lesion or symptom.	Confirmed lepers.		Clinical lepers.		Suspicious.	
	Cases.	Per cent.	Cases.	Per cent	Cases.	Per cent.
Pale macule	31	25.6	4	44.5	57	58.7
Pink macule	12	20.4	3	33.3	9	9.3
Anæsthesia	1	1.6	2	22.2	0	0
Flushing	0	0	0	0	5	5.1
No definite data	15	25.4	0	0	26	26.8

The pale macules are the commonest lesions observed, occurring in over 50 per cent of the positive and suspicious cases. The pink macules are also frequently seen; fifteen out of twenty-four cases showing such lesions were either confirmed lepers or clinically positive lepers. Anæsthesia was the first sign seen in one confirmed leper and in two clinically positive cases. Flushing of the legs was the exclusive sign in only 5 per cent of the suspicious cases.

Most of the children were too young to understand paræsthesia symptoms. In a group of one hundred fifty adult patients where early histories were carefully inquired into, fully 50 per cent felt these symptoms as the first manifestation of the disease or at least one of the earliest ones.

CONCLUSIONS

1. A single cutaneous lesion, which is believed to be the initial lesion, was observed in 75 per cent of the fifty-nine Culion children who have become definitely leprous.

2. In 25 per cent of these children no initial lesion could be found. The first clinical manifestations in them were a generalized rash or multiple macules appearing simultaneously.

3. The commonest sites of the initial lesion were the buttocks, cheeks, the posterior and lateral surfaces of the thighs, and the loins. The primary lesion was never seen on the chest or the abdomen, although these regions frequently show lesions in the more-advanced stages of the disease.

4. The initial lesion consists of a solitary pale or pinkish macule. In three cases the primary macule started from a scabies scar.

V[a]. EFFECT OF DELAYED SEGREGATION OF CHILDREN OF LEPERS

The removal of children of lepers from a leprous milieu immediately after birth is advocated by all leprologists as the only safe prophylactic measure against contagion of such children. In leprosaria where this practice is followed, the number becoming leprous is reduced to an insignificant minimum. Hasseltine[18] reports that of the one hundred twenty-one children of leprous parents born at the Molokai Leper Settlement during the period from July 1, 1909, to June 30, 1924, and removed immediately after birth to a nursery where they were cared for by nonleprous attendants, only one has developed leprosy. At the Almora Settlement in India, where for thirty years the children of lepers were brought up in a separate home, away from their parents, but one has become a leper.[19]

In 1916 a separate home was built within the staff reservation at Culion for the segregation of those children who did not yet show signs of leprosy. Isolation immediately after birth was attempted at the start but, owing to lack of proper facilities, this home was found to be unsuitable for infants and, therefore, only older children who no longer needed special care were admitted.

The Culion children may therefore be divided into two main groups: (1) Those who have lived continuously with their leper parents and have thus been exposed to the infection uninterrupt-

[18] U. S. Public Health Bull. 141 (1924).

[19] Jackson, In Leper Land. Marshall Brothers, London (1901) 108.

edly since birth; and (2) a much smaller group, made up of children who were segregated at the Negative Children's Home, away from leper surroundings, at ages varying from 4 months to 10 years, the average age being 3 years 6 months.

Effect of delayed segregation of children of lepers.—Since the establishment of the Negative Children's Home, March 25, 1915, to December 31, 1924, there have been one hundred twenty-three admissions to the home. Of this number twenty-nine have died, thirty have been returned to the Leper Colony as either positive or strongly suspicious lepers, twelve have been transferred to the settlement for causes other than leprosy, twenty have been discharged and given to nonleper relatives, and thirty-two were remaining at the home.

Table 15 gives the incidence of those becoming lepers, those remaining negative, those returned to the colony for causes other than leprosy, and the death rate among all the children admitted to the home, according to the age on admission.

TABLE 15.—*Incidence of leprosy among segregated children according to age on isolation.*

Age on admission.	Cases.	Returned to colony as lepers or suspected lepers.		Negative, discharged, and remaining.		Returned to colony for causes other than leprosy.		Deaths.	
		Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Years.									
0 to 1	38	2	5.2	14	36.9	7	18.4	15	39.5
1 to 2	36	10	27.8	12	33.4	4	11.1	10	27.8
2 to 3	16	6	37.5	7	43.7	1	6.3	2	12.5
3 to 4	10	2	20.0	8	80.0	0	0	0	0
4 to 5	8	5	62.5	2	25.0	0	0	1	12.5
5 to 6	5	3	60.0	1	20.0	0	0	1	20.0
6 to 7	5	1	20.0	4	80 0	0	0	0	0
7 to 8	3	1	33.3	2	66 6	0	0	0	0
8 to 9	1	0	0	1	100.0	0	0	0	0
9 to 10	0	0	0	0	0	0	0	0	0
10 to 11	1	0	0	1	100.0	0	0	0	0

Although the various groups are too dissimilar in size to allow accurate comparisons, it will be observed that, with the exception of the 3-to-4-year group, the incidence of leprosy tends to increase with the period of exposure up to the sixth year. The age at the time of admission to the home is considered as the "period of exposure" in the sense that Hollmann uses it in his article; that is, it indicates the length of time the child has been exposed to the disease. In the 5-to-6-year group

the incidence is practically the same as in the next preceding group; but thereafter it drops sharply, indicating that only a few of the children isolated after the age of 6 years developed the disease. The natural explanation for this is the elimination of the more-susceptible children who have become either positive or suspicious at earlier ages.

The percentage of those remaining negative among the segregated children does not show definite relation with those becoming positive. The twelve cases returned to the colony for reasons other than leprosy were children who did not thrive in the home and were returned to their parents at their request. All of these were below the age of 3 years.

Two of the thirty lepers were evidently infected during the first year of life, twelve before the end of the second year, and eighteen (60 per cent) before the fourth year.

The mortality was high among those admitted below the age of 1 year. There has been no death among those who were over 6 years old when admitted.

Comparison between the incidence of leprosy in segregated and in unsegregated children.—In order to determine the effects of delayed segregation of children of lepers it would be important to determine whether or not the incidence of leprosy has been diminished in such segregated children.

It has already been noted that, of the one hundred twenty-three admissions to the Negative Children's Home up to December 31, 1924, thirty have been returned to the colony as positive or strongly suspicious lepers, giving an incidence of 24.4 per cent. Only twenty-two of the thirty, however, were found to have been positive bacteriologically; the rest were either not bacteriologically examined at the time of transfer or were negative microscopically. Furthermore, the deaths, totaling twenty-nine out of the one hundred twenty-three cases, are included in Table 15. Therefore, considering only the positive cases and eliminating the deaths, the percentage of those who have become definitely leprous is found to be 23, which may be taken as the real incidence of leprosy among the segregated children.

Of the three hundred sixty-six unsegregated children living at Culion on December 31, 1924, forty-two, or 11.5 per cent, had become lepers. It is seen that, in the case of Culion children, delayed segregation has not only failed to diminish the incidence of leprosy but has also apparently increased it. This is certainly a most surprising result. Of course, certain factors have to

be considered in interpreting these findings. In the first place, there are more of the younger children among those remaining in the colony, tending naturally to lower the incidence of positive cases. Then there is the difference in size of the groups. Furthermore, the children at the home were more closely watched than were those not segregated. Had it been possible to make more frequent bacteriological examination of the suspicious cases in the latter group, it is probable that more positive cases would have been found. Making due allowance for these legitimate objections, however, the ratio still mitigates against delayed segregation, so that some other explanation must be sought.

After careful study of the data on hand I am inclined to ascribe this seemingly paradoxical result to the fact that the segregated children were as a rule less well cared for than were the children who were brought up by their own parents, so that the segregated children were less able to fight off the infection which most of them had doubtless acquired before segregation. Once more, the importance of the general health on the susceptibility to infection is clearly shown. Of the thirty-two remaining at the home on December 31, 1924, nineteen (59 per cent) showed macules or other suspicious lesions of leprosy.

Evidently, segregation of the children born at Culion must be done earlier than at present. Plans are under way to remodel the entire building, converting it into a nursery to which all children born in the colony will be removed as soon as possible after birth.

There is no difference in the ages at which the lesions became positive in segregated and unsegregated children; the average age in the unsegregated children was 5 years 9 months, and in the isolated children the corresponding average age was exactly the same.

V b. PROBABLE INCUBATION PERIOD IN SEGRAGATED AND UNSEGREGATED CHILDREN OF LEPERS

Basing their calculations on the data given by Gomez, Avellana Basa, and Nicolas on twenty-two segregated children who have become either positive or suspicious lepers, Rogers and Muir[20] have concluded that the average incubation period in these children was three and one-half years. How they obtained this figure is recorded by them as follows:

[20] Leprosy. W. Ward & Co., New York (1925).

* * * We have supposed susceptibility to be equal throughout the whole period of exposure and have taken half of this period to be the average time of infection; to this we have added the time which elapsed between isolation and the appearance of the first sign of the disease * * *.

They calculated half of the average period of exposure to be one year six months sixteen days, to which was added the average isolation period of two years eight days, giving the total of three years six months as the incubation period.

Following the method of Rogers and Muir, and considering only the positive cases in the series reported by Gomez et al., to which were added the eight new cases becoming positive after their report, I obtained an average incubation period of three years nine months, which closely approximates the figure obtained by Rogers and Muir.

Again, assuming that children of all ages are equally susceptible to infection, Rogers and Muir calculated that the probable average age at which infection took place in children who were continually exposed to their parents is half the period of exposure. As the average age at which the children living in the colony were found positive was 5 years 9 months, the incubation period calculated according to this method would be two years ten months.

Therefore, based on the methods of calculation proposed by Rogers and Muir, the incubation period for the segregated children would be three years nine minths, while in the unsegregated children it would be only two years ten months. However, since the average age at which the children were found positive is identical in both groups, it is probable that the average age at which infection took place is also the same in both. The amount of error in the method of calculating the average incubation in the segregated children should be slight, as the average period of exposure is comparatively short. Evidently the calculated figure for the unsegregated cases is erroneous, and an average incubation period of three years nine months in both groups probably is nearer right than is two years six months, proving that the younger children are more susceptible than the older ones.

Considering the incubation period in both groups, then, to be three years nine months, and subtracting this from the average age at which the children became positive, which is 5 years 9 months, the average age of infection would thus be 2 years.

It has not been possible to keep track of most of the children who have been given to nonleprous relatives. However, three of them have already been returned to Culion as lepers; two had been removed from Culion at the age of 2 years, and one at the age of 7 months 17 days. Of thirty cases sent away before the age of 6 months, none has been returned.

It is evident that, in the case of the Culion children, infection takes place on the average at about the second year, and after the sixth month.

It is obviously important to determine how long a child must be segregated before he can safely be discharged. The regulations at present followed at Culion prescribe an observation period of not less than four to five years in children who have been exposed to the disease for over six months. Although in the majority of the cases the leprotic lesions appeared well within a period of four years, one child developed the first suspicious signs four years two months after isolation; so that, to provide a fairly wide margin of safety, the observation period of such children should be definitely fixed at five years.

CONCLUSIONS

1. In a group of segregated children of lepers removed from all contact with the disease at an average age of 3 years 6 months, 23 per cent have become leprous.

2. Segregation of the children of lepers delayed after the age of 6 months does not decrease the incidence of leprosy, nor does it delay the appearance of the disease among them.

3. The probable average incubation period among the segregated and unsegregated Culion children is three years nine months.

4. The observation period for children of lepers segregated after the age of 6 months should cover at least five years.

ILLUSTRATIONS

PLATE 1

FIG. 1. Showing the development of the initial lesion from a scabies scar. *a*, old scabies scar; *b*, a fresh scar with a faint areola of depigmentation. This is ordinarily seen in Filipino children when such scars are recent; *c*, a suspicious macule of leprosy developing around an old scar; *d*, the initial lesion arising from a scabies scar. This lesion was positive for *Mycobacterium leprae*, but later became negative after six months' treatment.

2. Extensive, multiple macules.

PLATE 2

FIG. 1. Generalized pink macules in a girl three and a half years old. In this case, the initial lesion was not seen. The disease broke out in the form of a rash with considerable fever but without prostration.

2. A somewhat more advanced stage. Secondary lesions have appeared.

PLATE 3

FIG. 1. The initial lesion originating from an old scabies scar.

2. Another primary lesion.

TEXT FIGURE

FIG. 1. Chart showing the incidence of leprosy in male and in female children.

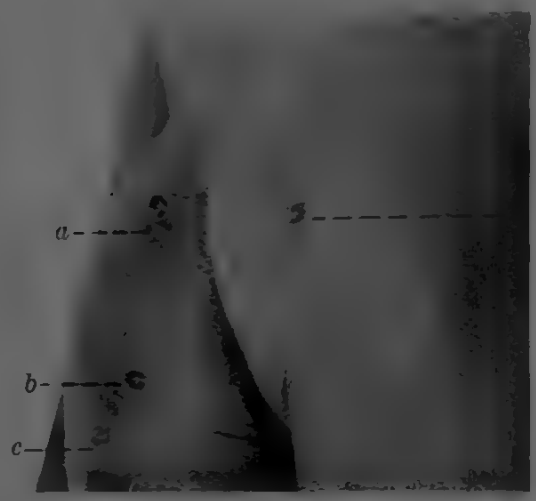

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PLATE 1.

PLATE 2.

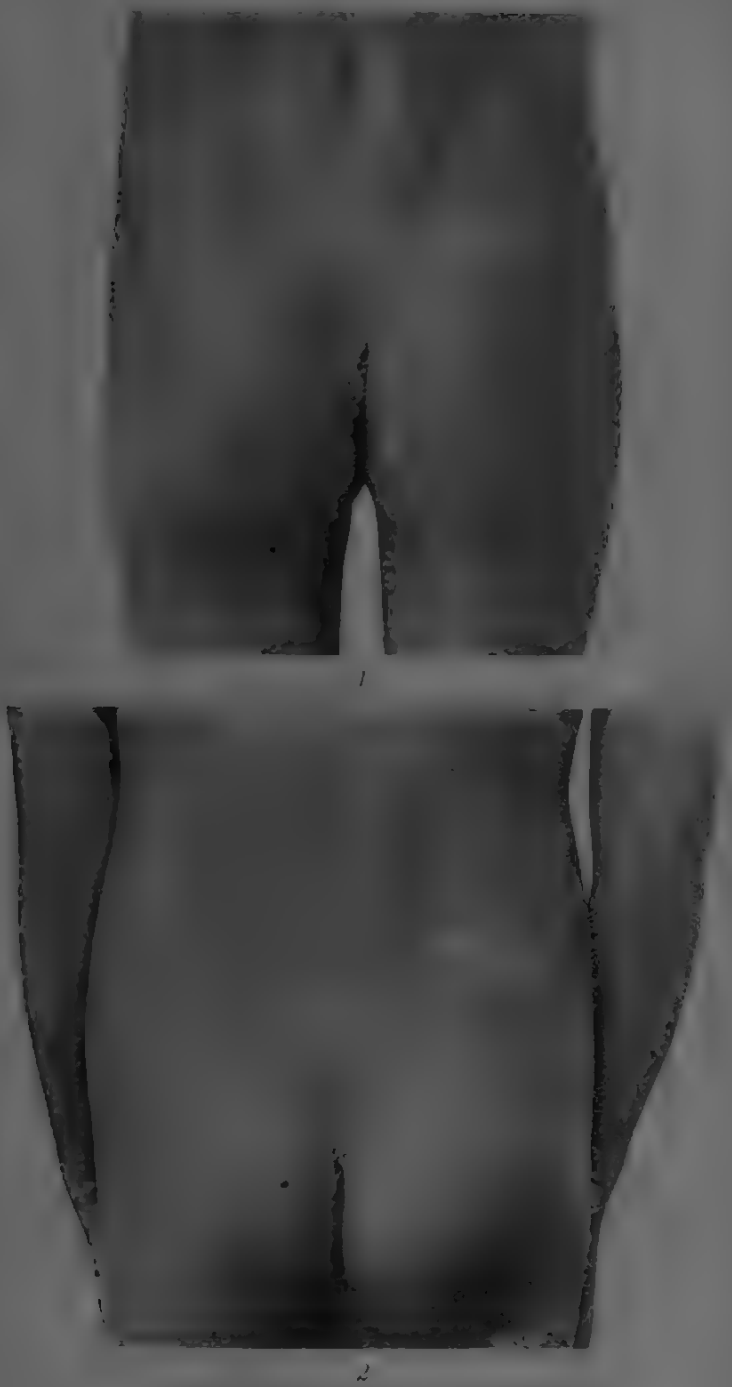

PLATE 3.

CONGENITAL ABSENCE OF BOTH HIND LEGS IN AN ADULT PIG

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TWO PLATES

INTRODUCTION

Malformations of the extremities in mammals are of various types, ranging from complete or partial lack of members to the presence of supernumerary limbs and digits. From a survey of the literature on hand, it is evident that cases of congenital absence of both hind legs are comparatively rare. Hence, it appears that there is some justification for reporting the present monster. Further, the data furnished by this specimen may constitute a definite contribution to our inadequate knowledge of the anatomical peculiarities of this form of abnormality in adults. Concerning the importance of studying various forms of malformation, Ballantyne(2) says the following:

> Indeed the inquiry into several types of malformation and structural anomaly has repeatedly thrown light not only on the malformation or anomaly itself but also upon the normal process of development the disturbance of which it represents.

A review of Piersol's(8) illustrations of the different classes of congenital deficiencies of the extremities in human beings failed to show a case in which both lower limbs were absent. Mall,(7) in his tables of various forms of localized anomalies in pathological and normal embryos, records no example of a human monster that falls in the same category as the specimen here reported. The occurrence of this deformity in domestic animals is frequently heard of; but, so far as I was able to learn, the only case recorded that closely resembles this one is the two-hour-old pig reported by Carreon.(3) His specimen, in addition to the absence of both hind legs below the femur, is characterized by the presence of cleft palate, a condition not observed here. Craig(5) and Williams,(10) in their treatises on monstrosities, neither mention nor illustrate a case with both

hind legs missing. Perhaps the lack of clinical importance that the present type of monster offers accounts for this omission.

Like many other forms of localized anomalies, the etiology of congenital deficiencies of the extremities is still a matter of uncertainty. The drift of opinion, however, among investigators is toward the conclusion that they are not due to hereditary and germinal influences. Mall(6) seems to advocate the theory that they are due to arrest of development arising from defective nutrition. Piersol,(8) on the other hand, seems to entertain the idea that amniotic bands and adhesions are potent causes in the production of congenital deficiencies of the extremities.

MATERIAL

The present pig monster was obtained from the department of animal husbandry, College of Agriculture, through the kindness of Mr. Mondeñedo, to whom I wish to express my sincere thanks for having made the present study possible. The pig was presented to the department by a student and it was exhibited at the Laguna Provincial Fair, held on the campus of the Los Baños College from May 24 to 31, 1924. It was a boar, 25.5 kilograms in weight, 73 centimeters in body length (crown–rump measurement), 59 centimeters in height, and 65.5 centimeters in body circumference (measurement taken behind the dorsal angle of the scapula). No record was available of the exact age and parental history. Judging, however, from the general appearance of the animal and from the length of the tusks, it was doubtless a native pig of about 4 years of age.

Before the animal was killed and embalmed, a thorough examination of the different parts of the body was made, and its attitude both at rest and in motion carefully observed for several days. The photograph of the monster in its favorite position is shown in Plate 1, fig. 1. It is interesting to note that, in spite of the missing hind legs, the animal was able to move from place to place. While moving, the perineal region had to be rubbed against the floor, and the trunk held in so oblique a position that its long axis formed an angle of about 45° with the ground plane. The animal had perfect control over its hind parts; they could be extended or flexed at will. While eating it maintained a position with the knees resting on the ground and with the trunk so twisted that the right hip region had to come in contact with the ground. In a recumbent position it preferred to lie on the right side. Apparently the assistance rendered by the femur in rising accounts for this.

The sexual instinct seemed to be perfectly normal. In the presence of a sow, especially a strange one, the pig invariably showed erection of the penis and other symptoms of ardent desire for sexual intercourse. As one can easily conceive, however, attempts to mount always failed.

SURFACE ANATOMY

The skin of the dorsal aspect of both knees was abnormally thick, free from hair, and somewhat horny. The mammary glands were uneven in number, there being only four teats on the left side, one less than on the right. There was a complete fusion of the soles and the lower parts of the interdigital surfaces of the hoofs of the third and fourth digits of the right anterior foot. The hind legs were completely absent; otherwise, the pig appeared to be a perfectly normal individual. Careful inspection and palpation of the deformed hind parts revealed the presence of a ventral cutaneous pouch on the right side. The bottom of the pouch was thick, hairless, and somewhat scaly, indicating evidently its frequent rubbing against the ground during life. Inclosed within the pouch, but not attached to it, was felt a hard rounded mass, which, upon dissection, proved to be the distal extremity of the right femur. It was observed that the animal had to depend very much upon this bone in supporting the weight of the caudal portion of the body while getting up and moving from place to place.

The left gluteal region was slightly depressed, due evidently to its poorly developed muscles, which subject will be alluded to later. About 5.5 centimeters from the root of the tail and about 2 centimeters from the dorsal median line was a well-defined eminence which, upon dissection, proved to be due to the deformity of the transverse processes of the fourth and fifth coccygeal vertebræ. In the examination of the perineal region, only the left testicle was discovered; the right one was found to lie in front of the distal fourth of the right femur and underneath the fold of the flank. The penis presented no apparent abnormality, except the slight displacement of its body toward the right side. Apparently the stretching of the skin toward that side accounts for this condition.

INTERNAL ANATOMY

A general statement should be made here, to the effect that, aside from the hind quarters and one of the fore feet, all other parts of the body of this pig monster—including the bones,

muscles, heart, principal arteries, veins and nerves, respiratory apparatus, central nervous system, and digestive and urinary organs—were observed to be perfectly normal. For this reason, it is believed that it would be superfluous to include their description in the present brief account. As will be noted, the following discussion of the internal anatomy is mostly confined to the parts that were found to be involved in the deformity.

SKELETON

In the deformed hind parts of the present specimen the bones that were discovered to be affected were the lumbar vertebræ, the sacrum, the coccygeal vertebræ, and the bones of the pelvic limbs. These bones are all illustrated in Plate 1, fig. 2. With the exception of the fusion of the lower margins of the interdigital surfaces of the third phalanges of the third and fourth digits of the right anterior limb, the rest of the bones of the fore limbs appeared to be perfectly normal.

The last of the five lumbar vertebræ that were present is the only one that presented some abnormal features. Its left arch was fused completely with the anterior border of that of the first sacral vertebra but it failed to fuse with its fellow on the right side, the two arches having been united by only the fibrous connective tissue. The spinous process was supported by the right arch only and was comparatively smaller than any of those of the first four vertebræ. Its direction was toward the left side. The transverse processes differ in size, the left one being much broader and longer than the right. According to Sisson(9) and Chauveau,(4) the transverse processes of the last lumbar vertebra in a normal pig form no articulation with the sacrum. In this specimen, however, they were observed to articulate not only with the sacrum but also with the ilium.

The sacrum was very much deformed and presented only three rather imperfectly developed vertebræ. The first one offered the most-striking characteristic features. Its arches were not fused but only overlapped each other. The left arch was more extensive than the right and presented a fairly well-developed spinous process which was directed toward the right side. The left sacral wing was very poorly formed and was not fused with the body; its attachment to the latter was by means of a thin plate of cartilage. The dorsal sacral foramina on the left side were placed somewhat farther forward than were those on the opposite side.

There were only eleven coccygeal vertebræ. The absence of functional articular processes and complete arches on the first five, and the division of the transverse processes of the fourth and fifth into dorsal and ventral plates were the most salient aberrant features.

The shaft of the ilium of the left os coxæ seemed to be more massive than that of the right. The left acetabulum was absent, and in its place was found a tuberosity, the medial surface of which formed a deep groove with the ischium and the pubis. In the right os coxæ, the only feature deserving notice was the depression situated on the lateral surface of the ischium, just below and behind the ischiatic spine. To this depression was fitted the summit of the trochanter major of the right femur.

Below the os coxæ on the left side, the only bone found was the rudiment of the proximal extremity of the femur. It was a small flattened bone measuring about 3 centimeters in length and 2 centimeters in its widest middle part. Its direction was forward and upward, and it formed no articulation with the os coxæ. The anterior extremity and the anterior half of the lateral surface were rough and furnished attachments to muscles. The inferior border presented a well-defined central eminence which was found to articulate below with a piece of cartilage.

In the right pelvic limb, the only bones that were present below the os coxæ were the femur and the patella. The fovea capitis was absent; otherwise the proximal extremity of the femur appeared to be normal. The trochlea and the condyles, however, of the distal extremity were imperfectly developed. The intercondyloid fossa was represented by only a narrow, shallow groove. The shaft was not so massive as in a normal individual. There was no evidence of either the lateral or the medial supracondyloid crest.

Comparison of the length of the femur and that of the humerus on the same side showed that the former was 0.3 centimeter shorter than the latter, its length being 15.2 centimeters as against 15.5 centimeters for the humerus. This condition evidently shows that the femur did not reach its full development even in length, because, when the femur and humerus of the skeletons of five adult normal pigs were compared, it was found that, invariably, the femur exceeded the humerus in length by an average of 4.86 centimeters.

The patella was somewhat spherical, and it was found to articulate with the lower part of the anterior surface of the

femur, instead of with the trochlea. Arising from its lower part was a single broad ligament which passed over the trochlea to be attached to a shallow, transverse depression at the junction of the trochlea and the condyles.

MUSCLES

For the sake of brevity, the most salient aberrant features presented by the individual muscles in the deformed hind parts are summarized as follows:

MUSCLES OF THE LEFT HIP AND THIGH

Tensor fasciæ latæ.—Very much undersized; posteriorly, it was fused with the gluteus superficialis, and deeply with the anterior part of the gluteus medius. Below, it had no direct attachment to any bone; its aponeurotic portion simply blended with the fascia covering the ischiatic division of the biceps femoris.

Gluteus superficialis.—Represented by a narrow thin muscle which joined the sacral division of the biceps femoris on its way down. This muscle corresponds to the ilial head found in the horse which, as a rule, does not exist in a normal pig. The muscle had its origin in the tuber coxæ and was inserted in the dorsal part of the tuber ischii, in common with the sacral portion of the biceps femoris.

Gluteus medius.—Comparatively small and tendinous, and the insertion was anomalous. The deep part or gluteus accesorius terminated in a strong tendon which passed backward, downward, and then forward through the groove formed by the tuberosity and the ischium and pubis, as already referred to in connection with the description of the left os coxæ. It joined the common tendon of the iliacus and psoas major. The superficial part was also provided with a tendon which was inserted in the anterior aspect of the cartilage that was found articulating with the rudiment of the proximal extremity of the femur.

Gluteus profundus.—Very poorly developed, being represented only by a small, flat, tendinous structure, having its origin from the superior ischiatic spine and adjacent part of the shaft of the ilium. It was provided with a terminal tendon which joined that of the deep part of the gluteus medius.

Biceps femoris.—Appeared to be rudimentary. Its sacral and ischial divisions presented a peculiar relation; the former formed an angle of about 80° with the latter. The sacral division originated from the gluteal fascia principally and was inserted in the tuber ischii, in common with the gluteus superficialis. Its tendon of insertion was partly under cover of the superficial part of the ischial division. The latter division could be separated into superficial and deep parts. The superficial part had its origin from the tuber ischii, below and behind the insertion of the gluteus superficialis, and it was inserted in the abdominal fascia. The deep part was found lying under cover of the semimembranosus from which it was difficult to separate it. The origin was on the tuber ischii and the adjacent part of the lateral surface of the ischium, and the insertion was on the

rough anterior half of the lateral surface of the rudiment of the proximal extremity of the femur.

Semitendinosus.—Very small and narrow, lying behind the sacral division of the biceps femoris; the ischial head was apparently absent. The muscle was attached above to the dorsal plates of the split transverse processes of the fourth and fifth coccygeal vertebræ, and below to the tuber ischii.

Semimembranosus.—Thin and very poorly developed. The fibers were directed forward and slightly upward. Posteriorly it was attached to the fascia of the perineum and anteriorly it was blended with the deep part of the ischial division of the biceps femoris, which had its insertion on the rough anterior half of the rudiment of the proximal extremity of the femur.

Sartorius.—Abnormally short and narrow. It terminated below by just joining the gracilis at a right angle.

Gracilis.—Very rudimentary, consisting of only a thin, rather tendinous structure of about 1.5 inches in width. It was directed outward and was inserted in the fascia covering the semimembranosus and the adjacent part of the ischial division of the biceps femoris.

Pectineus.—Abnormally small and so flattened that it looked as if it were a part of the preceding muscle, from which it could be separated only with difficulty. The prepubic tendon was its principal point of origin, and the fascia covering the semimembranosus and biceps femoris furnished its insertion.

Adductor.—Very rudimentary and was inserted in the posterior end of the cartilage that was found articulating with the rudiment of the proximal extremity of the femur.

Obturator externus and obturator internus.—Both provided with terminal tendons which united to form a common tendon. The conjoined tendon passed forward and upward to terminate in the tendon of insertion of the gluteus accessorius.

Quadriceps femoris.—Of the four heads only the rectus femoris was present. It consisted of a very short tendinous structure that was found attached above to the border of the shaft of the ilium, and below to the rough anterior end of the rudiment of the femur.

Iliacus and psoas major.—The only sublumbar muscles that were observed to present some abnormal features. They were very much undersized and their common tendon of insertion joined that of the gluteus accessorius, as stated elsewhere in this paper.

MUSCLES OF THE RIGHT HIP AND THIGH

Tensor fasciæ latæ.—Comparatively better developed here than on the opposite side. It terminated in a thin aponeurosis which blended below with the thick layer of fibrous tissue lining the cutaneous pouch.

Gluteus superficialis.—Presented no ilial part and was abnormally long, its terminal tendon being attached to the lateral epicondyle of the femur.

Biceps femoris.—Better developed than its fellow on the other side. The sacral and ischial divisions were fairly distinct and presented no obvious aberration in their points of origin. The sacral division, on its way down, was partly attached to the upper part of the tuber ischii, and it was provided with a narrow tendon which blended with the superficial layer of

the fibrous connective tissue capsule covering the distal extremity of the femur. The ischial division was separable into anterior and posterior parts, the former lying medial to the sacral division, and the latter behind it. The posterior part was attached above to the upper part of the tuber ischii, just below the attachment of the sacral division, and below to the fibrous connective tissue capsule referred to above. The anterior part had its origin from the lateral surface of the ischium and the tuber ischii, and it was inserted in the upper two-thirds of the lateral border of the femur.

Semitendinosus.—The sacral part was similar in attachment to its fellow on the other side. The ischial part was attached above to the tuber ischii, immediately behind the biceps femoris, and below, by means of its strong aponeurosis, to the thick deep layer of the fibrous connective tissue capsule covering the distal extremity of the femur.

Semimembranosus.—Had its distal attachments to the lower fourth of the posterior surface of the femur and to the medial epicondyle.

Gracilis.—Presented a caplike distal portion which covered the lower end of the femur, just outside the fibrous connective tissue capsule. Its insertion was found to be on the patella and lateral epicondyle of the femur.

The gluteus medius, gluteus profundus, quadriceps femoris, adductor, pectineus, obturator externus and internus, iliacus, and psoas major and minor appeared to be better developed than their respective fellows on the left side; and in their relations and attachments they presented nothing of interest. In Plate 2 are illustrated the superficial muscles of the right and left hips and thighs.

BLOOD SUPPLY OF THE DEFORMED PARTS

The renal arteries and the posterior or small mesenteric artery were apparently normal, both in size and in points of origin. The right internal spermatic artery, however, was observed not to rise directly from the aorta (as in the case of its fellow on the other side), but from the root of the posterior mesenteric artery. The latter blood vessel was given off from the ventral aspect of the aorta, a little below the level of the origin of the left internal spermatic artery. No obvious abnormality was observed in the relations of the terminal branches of the abdominal aorta at their points of origin; their collateral and terminal branches were distributed as follows:

The external iliac arteries.—Both left and right circumflex arteries, the first branches given off, presented nothing of special interest. The left circumflex artery was followed by two large but short branches which apparently had no homologue on the right side. They were very close at their points of origin and ramified in the tensor fasciæ latæ and prefemoral lymph gland. On the right side the muscle and the lymph gland received their blood supply from the branches of the right circumflex

artery. The next collateral branch given off by the external iliac artery on either side was a large, long one. It supplied the sartorius, gracilis, and semimembranosus muscles on the corresponding side. The last branch was comparatively smaller than the preceding, especially on the left side; it terminated in small twigs which ramified in the rectus abdominis and superficial inguinal lymph gland. The terminal branches of the external iliac artery were distributed chiefly to the pectineus, obturator externus, and adductor.

The internal iliac or hypogastric arteries.—The largest two collateral branches of these blood vessels were the anterior and posterior gluteal arteries. The former appeared to be perfectly normal, both in size and in general distribution. The right posterior gluteal artery, however, was much longer and larger than the corresponding left one. This condition may be accounted for by the better development on the right side of the biceps femoris, semitendinosus, and other adjacent muscles, to which the principal branches of the artery in question were chiefly distributed. The internal iliac artery on either side was continued backward by the internal pudic artery which, after giving off branches to the rectum, urinary bladder, and accessory genital organs, passed backward to the ischial arch where it terminated in two branches, the arteria dorsalis penis and the arteria profunda penis.

The middle sacral artery.—This blood vessel had its origin from the dorsal aspect of the aorta, a little above the bifurcation of the latter into left and right internal iliac arteries. It seemed to be unusually small and was continued backward by the middle coccygeal artery. About 1.5 centimeters from its point of origin it gave rise to the last pair of the lumbar arteries.

NERVE SUPPLY OF THE DEFORMED PARTS

Both the location and the formation of the lumbo-sacral plexus, from which are derived the nerves of the pelvic limb, were observed to be perfectly normal; its last three lumbar (ventral branches) and first sacral components could be easily recognized. Its principal branches (the femoral, obturator, anterior gluteal, posterior gluteal, and great sciatic nerves) were apparently normal in their points of origin and relation, but they seemed to be abnormally small in caliber. No attempt was made to trace the final ramifications of the branches of the nerves above mentioned.

GENITAL ORGANS

The features that were observed to be anomalous in the genital organs were the slight displacement of the body of the penis toward the right side, the location of the right testis in the lower part of the flank, the very poorly developed tunica vaginalis on the right, and the marked difference in size of the two sex glands. The right testis was very much smaller than the left and was provided with an abnormally thin tunica vaginalis.

The latter structure was closely applied to the aponeurotic portion of the obliquus abdominis externus, to which it was attached by loose fibrous connective tissue. Including the epididymis, the right testis measured 5 centimeters in length and weighed 26.5 grams, whereas the left one measured 8.6 centimeters and weighed 54.4 grams. Histological examination showed that both glands were normal; the presence of fully developed spermatozoa in the tubules of the epididymis of either gland suggests that they were also functional.

SUMMARY AND CONCLUSIONS

1. A review of the available literature on teratology showed that cases of congenital absence of both hind legs in mammals are comparatively rare, and that, like other forms of localized anomalies, the etiology of this type of malformation has not been definitely determined.

2. At least in pigs, complete or total absence of both hind legs does not seem to render life impossible. It is beyond question, however, that with such deformity the struggle of the individual for existence must be painful and difficult.

3. According to the classification of malformations of the extremities, adopted by Bailey and Miller,(1) the present pig monster falls under abrachius apus, which implies the suppression of either the thoracic or the pelvic limbs, the remaining pair being normal.

4. With the anatomical data furnished by the present specimen it is very difficult, if not impossible, to decide what constituted the immediate cause of the arrest of development of the hind limbs. I believe, however, that the absence of any external indication of atrophied extremities is sufficient evidence that the deformity was not brought about by the amputation of the already formed legs by the encircling amniotic band or the umbilical cord.

5. With the exception of the complete fusion of the soles and the lower parts of the interdigital surfaces of the hoofs of the third and fourth digits of the right limb, and the partial fusion of the corresponding phalanges, the anterior extremities of this pig presented nothing unusual.

6. The bones that were found to be included in the deformity were the lumbar, sacral, and coccygeal vertebræ, the ossa coxarum, and the femora. Below the os coxæ on the right side

only the imperfectly developed femur and patella were present, and on the left, only the rudiment of the proximal extremity of the femur.

7. The left side seemed to be more severely affected, the femur being represented by only the rudiment of its proximal extremity, and the muscles comparatively poor in development. The quadriceps femoris, which was found to possess four fairly well developed heads on the right side, was represented here by only the rudiment of the rectus femoris.

8. No distinct quadratus femoris and gemellus could be recognized on either side. In general, the most striking anomalies of the muscles were their development and insertions.

9. Whether the muscle anomalies in the present case are a consequence of the defects of the skeleton or were independent of them is not known.

10. The abdominal aorta and its branches presented nothing to cause suspicion of defective development of the early embryonic circulatory system in the deformed hind parts of the animal. Neither did the blood vessels that were distributed to the different muscles present evidence that any abrupt changes had taken place during the early part of the development of the pelvic limbs.

11. The erection of the penis and the exhibition of other symptoms of ardent desire for sexual intercourse, when in the presence of the opposite sex, are conclusive evidence that the sexual instinct was not at all deranged.

12. Aside from the comparatively small size and the displacement of the right testis in the region of the flank, the sex glands appeared to be normal, both in structure and in function. The penis presented no noticeable abnormality, other than the slight displacement of its body toward the right side.

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ILLUSTRATIONS

[Photographs by Mr. Dionisio Aquino, Department of Agronomy, College of Agriculture.]

PLATE 1

FIG. 1. The pig monster in its favorite posture.

2. Showing the bones present in the deformed hind parts of the animal. 1, lumbar vertebræ; 2, 2′, sacrum; 3, coccygeal vertebræ; 4, 4′, ossa coxarum; 5, right femur; 6, right patella; 7, the rudiment of the proximal extremity of the left femur.

PLATE 2

FIG. 1. Showing the relations of the superficial muscles of the left hip and thigh. 1, gluteus medius; 2, sacral division of the biceps femoris; 3, tensor fasciæ latæ; 4, ischial division of the biceps femoris; 5, semimembranosus; 6, semitendinosus; 7, sphincter ani externus; 8, left testis; 9, cutaneous pouch; 10, aponeurotic portion of the obliquus abdominis externus; 11, superficial inguinal lymph gland; 12, prefemoral lymph gland; 13, tuber coxæ; 14, body of the penis; 15, gluteus superficialis; 16, anus.

2. Showing the relations of the superficial muscles of the right hip and thigh and the location of the right testis. 1, gluteus medius; 2, tensor fasciæ latæ; 3, gluteus superficialis; 4, quadriceps femoris; 5, sacral division of biceps femoris; 6, ischial division (superficial part) of biceps femoris; 7, semitendinosus (ischial part); 8, sphincter ani externus; 9, right testis (still covered with tunica vaginalis); 10, thick layer of fibrous connective tissue lining the cutaneous pouch; 11, obliquus abdominis externus; 12, tuber coxæ; 13, prefemoral lymph gland; 14, gracilis (posterior part); 15, caplike portion of the gracilis over the distal extremity of the femur; 16, anus.

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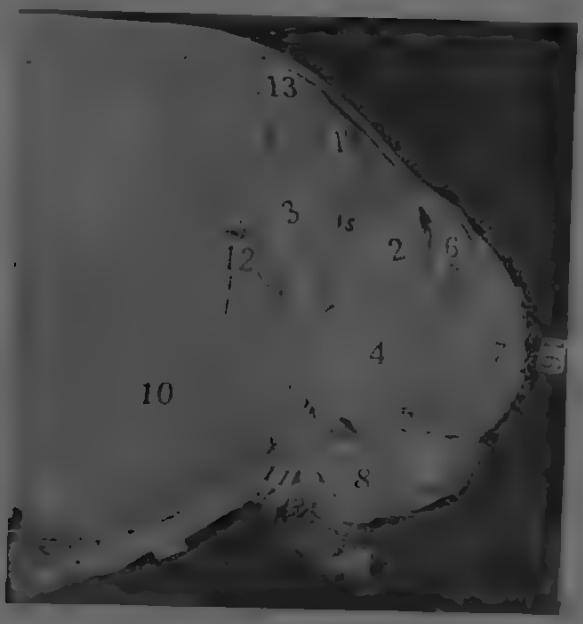
PLATE 1



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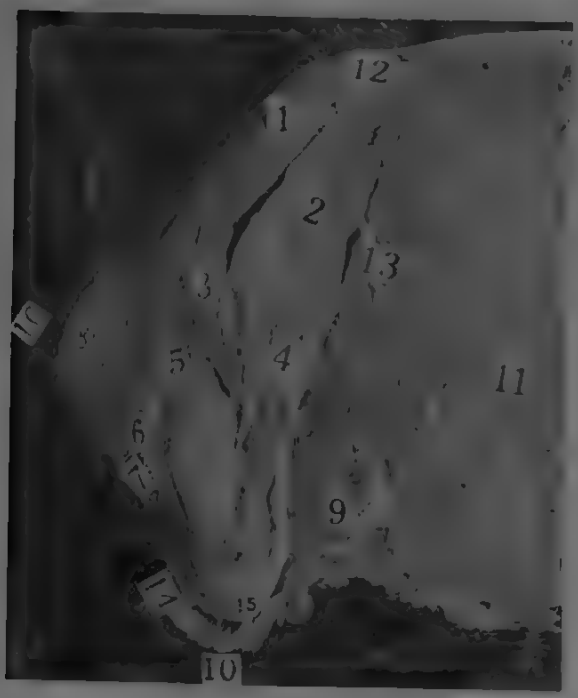

2

PLATE 2.

ESTERS OF CHAULMOOGRIC ACID (CAPRYL, ALLYL, PHENYL, ORTHO CRESOL, META CRESOL, PARA CRESOL)

By P. P. HERRERA-BATTEKE

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and

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The treatment of leprosy by means of the mixed ethyl esters obtained from the fatty acids of chaulmoogra oil has given excellent results. However, as this method of treatment is a slow process it would seem highly desirable to prepare other chaulmoogra derivatives which may, perhaps, have greater therapeutic value than the mixed chaulmoogra ethyl esters. Some work along this line has already been carried out in various laboratories.

Power and his associates [1] were the first to make a thorough investigation of chaulmoogra oil. Power prepared the methyl and ethyl esters and a number of salts and derivatives of chaulmoogric acid, which is one of the principal constituents of chaulmoogra oil. Power considered chaulmoogric acid to be an equilibrium mixture of two isomers. He proposed the following as one of the two possible formulas of chaulmoogric acid:

The recent investigation of Shriner and Adams [2] appears to confirm this formula as representing in a satisfactory manner the chemical behavior of chaulmoogric acid and seems to establish the fact that chaulmoogric acid does not exist in a tautomeric state.

Perkins [3] prepared the propyl, butyl, and amyl esters of the

[1] Power, F. B., and F. H. Gornall, Journ. Chem. Soc. Trans. 85 [1] (1904) 838 and 851; Power, F. B., and M. Barrowcliff, ibid. 87 (1905) 884.

[2] Journ. Am. Chem. Soc. 47 (1925) 2727.

[3] Philip. Journ. Sci. 24 (1924) 621.

mixed chaulmoogra acids. Some mercury derivatives [4] have also been made.

Leonard Rogers [5] used a mixture of sodium salts of the fatty acids of chaulmoogra oil for the treatment of leprosy. Walker and Sweeney [6] found that both sodium and potassium salts of the total fatty acids of chaulmoogra oil have a high selective antiseptic action on acid-fast bacilli, but the other ordinary salts of chaulmoogra acids are insoluble in water and therefore unsuitable for practical use.

Schöbl [7] carried out an extensive investigation on chaulmoogra derivatives and numerous other compounds, to determine their growth-inhibiting activity toward acid-fast bacilli in vitro. In a subsequent research Schöbl [8] concluded that the growth-inhibiting activity of chaulmoogra oil depends principally on the unsaturated ring structure of the compounds contained in the oil because, when it was hydrogenated and the unsaturated glycerides converted to saturated glycerides, the oil lost its growth-inhibiting activity. The experiments carried out by Schöbl also indicated that the length and structure of the side chain of chaulmoogric-acid derivatives influenced the therapeutic activity of these substances.

In addition to the work that has been done on chaulmoogra derivatives and similar substances, other *Hydnocarpus* oils similar to chaulmoogra have been investigated.[9]

EXPERIMENTAL DATA

The chaulmoogra oil used in this investigation was obtained from the seeds of the variety of chaulmoogra known as *Taraktogenos kurzii* (King). Our supply of oil was kindly presented to us by Dr. G. A. Perkins, chief chemist of Culion Leper Colony.

Chaulmoogric acid.—In preparing chaulmoogric acid the chaulmoogra oil was saponified in the usual manner with alcoholic (aldehyde-free) potassium hydroxide. The excess alcohol was eliminated by distillation and the residual soaps then decomposed with dilute hydrochloric acid. The mixed acids thus obtained

[4] Dean, A. L., R. Wrenshall, and G. Fujimoto, Journ. Am. Chem. Soc. 47 (1925) 403.

[5] Ind. Journ. Med. Rev. 5 (1917) 277.

[6] Journ. Inf. Dis. 1 (1920) 1.

[7] Philip. Journ. Sci. 25 (1924) 123.

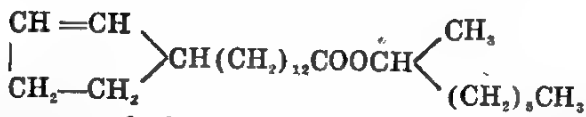
[8] Philip. Journ. Sci. 25 (1924) 135.

[9] Perkins, G. A., and A. O. Cruz, ibid. 23 (1923) 543; Schöbl, O., ibid. 23 (1923) 535; 24 (1924) 23.

were then poured into a large beaker and, on standing, they solidified as a hard soapy mass. The acids were then filtered and washed with water until the aqueous filtrate was no longer acidic to litmus. The acids were then dried on sheets of filter paper, after which they were crystallized from each of the following solvents: Ethyl alcohol (95 per cent), methyl alcohol, petroleum ether, and acetone. By this procedure the chaulmoogric acid was obtained as glistening plates, which melted at 68°.

Chaulmôogra oils usually contain varying amounts of resinous matter. The crystallization from petroleum ether is very necessary, as the yellow resins are thus precipitated while the chaulmoogric acid dissolves, giving a colorless solution. Sometimes a portion of the resins remains in solution in a somewhat colloidal form. In such a case it is advisable to add anhydrous sodium sulphate to the hot petroleum ether solution of chaulmoogric acid. The sulphate tends to break up the colloid and precipitate the resins more completely.

CAPRYL ESTER OF CHAULMOOGRIC ACID

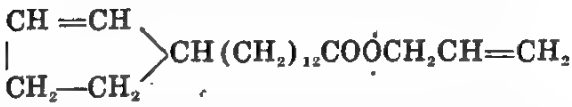


Thirty grams of chaulmoogric acid were dissolved in 200 cubic centimeters of ether. Thirty grams of capryl alcohol (methyl-hexyl-carbinol or secondary octyl alcohol), which had been previously dried with anhydrous sodium sulphate and redistilled, were added to the ethereal solution of chaulmoogric acid. The flask containing the mixture was immersed in a bath of ice and water. Hydrochloric acid gas was then prepared by allowing concentrated sulphuric acid to drop from a dropping funnel into a filter flask containing fused ammonium chloride. The hydrochloric acid gas was then dried by passing it through a wash bottle containing concentrated sulphuric acid, after which the dried gas was passed for about two hours into the well-cooled ethereal solution of chaulmoogric acid and capryl alcohol. The mixture was then heated on a water bath (reflux) for three days. The reaction product was treated with water and the ester layer separated. The ester was then dissolved in ether and the solution neutralized with dilute sodium carbonate solution. A somewhat thick emulsion was formed at this stage, but this was broken up by adding a saturated

solution of sodium chloride, shaking, and separating the ether layer. The ethereal solution of the ester was washed with water and separated, after which the solution was dehydrated with anhydrous sodium sulphate, filtered, and the ether removed by distillation. When the ester was distilled in vacuo it was obtained as a colorless oil with a peculiar characteristic odor. The mean boiling point was 214.6° C. (corrected) at 0 millimeter pressure. The actual yield was 14 grams, or 33 per cent, of the theoretical yield. When the formula of the ester was checked by analysis the following results were obtained:

	Carbon.	Hydrogen.
	Per cent.	Per cent.
Calculated for $C_{28}H_{48}O_2$	79.60	12.25
Found:		
I	79.45	12.20
II	79.06	12.28

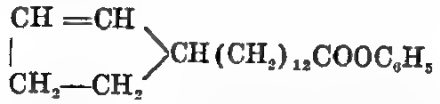
ALLYL ESTER OF CHAULMOOGRIC ACID



This ester was prepared in the same manner as the capryl ester. Thirty grams of chaulmoogric acid were dissolved in 150 cubic centimeters of ether and to the mixture 20 grams of allyl alcohol were added. The mixture was cooled, treated with hydrochloric acid gas for two hours, and heated (reflux) for three days. The reaction product was then treated with water and the ether layer separated. The ethereal solution of the ester was then treated with dilute sodium carbonate solution, then with salt solution, and washed several times with water. After separating from the water the solution was dehydrated and distilled to remove the ether. The ester was then distilled in vacuo. The purified ester was a colorless oil, which had a characteristic odor. The mean boiling point was 222.3° C. (corrected) at 5 millimeters pressure. The yield obtained was 26 grams, which is equivalent to 75.8 per cent of the theoretical yield. Analysis gave the following results:

	Carbon.	Hydrogen.
	Per cent.	Per cent.
Calculated for $C_{21}H_{36}O_2$	78.75	11.25
Found:		
I	78.60	11.61
II	78.53	11.66

PHENYL ESTER OF CHAULMOOGRIC ACID

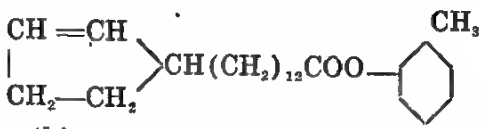


Twenty-eight grams of chaulmoogric acid were treated with 10 grams of redistilled phenol and the mixture heated in an oil (Crisco) bath to a temperature of 135°. To this mixture 8 grams of phosphorus oxychloride were then added gradually in small portions. When there was no further evolution of hydrogen chloride gas the bath was allowed to cool to a temperature of 120° and this temperature was maintained for about ten minutes until the reaction was apparently finished. The reaction product was then poured into cold water. The ester separated as an oil, which had a slightly reddish color. The mixture was neutralized with dilute potassium hydroxide solution and extracted with ether. The ether extract was washed with water and dehydrated with anhydrous sodium sulphate, after which the ether was removed by distilling. When distilled in vacuo the ester distilled over at about 233° C. (corrected) as a colorless heavy oil which solidified in the receiver. The solid ester was then crystallized from ethyl alcohol (95 per cent) and obtained as colorless, odorless crystals, which melted at 40° without decomposition. The ester was soluble in the usual common organic solvents but insoluble in water. The yield obtained was 15 grams, equivalent to 42 per cent of the theoretical yield.

Analysis gave the following results:

	Carbon.	Hydrogen.
	Per cent.	Per cent.
Calculated for $C_{24}H_{36}O_2$	80.90	10.11
Found	80.74	10.76

ORTHO CRESOL ESTER OF CHAULMOOGRIC ACID



In preparing this ester, phosphorus oxychloride was used as a condensing agent, as in the preparation of the phenyl ester.

Twelve grams of freshly distilled ortho cresol were added to 28 grams of chaulmoogric acid and the mixture was heated in an oil bath to a temperature of 135°. Phosphorus oxychloride (8 grams) was added gradually to this mixture in small por-

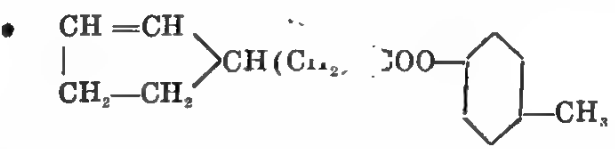
tions. The mixture was then heated to 150° and this temperature maintained until no more hydrogen chloride gas was given off. The temperature was then allowed to decrease to about 120°, after which the mixture was poured into water, neutralized with dilute potassium hydroxide solution, and extracted with ether. The ethereal solution was then dehydrated with anhydrous sodium sulphate and the ether eliminated by distilling. The ester was then distilled in vacuo and thus obtained as a colorless solid. The ester was further purified by treating with cold petroleum ether; some unchanged chaulmoogric acid crystallized out while the ester remained in solution. The solution was filtered to remove the chaulmoogric acid and the petroleum ether eliminated by distilling. The ester was again distilled in vacuo and obtained as a colorless liquid, which had an odor somewhat like ortho cresol. The mean boiling point was 218.8° C. (corrected) at about 0 millimeter pressure. The yield was 18.5 grams, equivalent to 50 per cent of the theoretical yield.

Analysis gave the following results:

	Carbon.	Hydrogen.
	Per cent.	Per cent.
Calculated for $C_{25}H_{38}O_2$	81.08	10.27
Found	81.16	10.44

The ester gave no color test with ferric chloride, thus showing the absence of free cresol.

PARA CRESOL ESTER OF CHAULMOOGRIC ACID



The para cresol ester of chaulmoogric acid was prepared from para cresol and chaulmoogric acid. The procedure followed was the same as that used in preparing the ortho cresol ester.

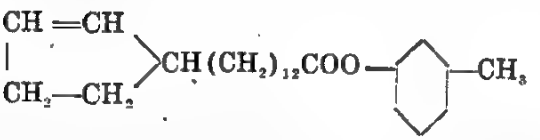
Twenty-eight grams of chaulmoogric acid were mixed with 12 grams of para cresol, and 8 grams of phosphorus oxychloride were used as a condensing agent. The para cresol ester was a colorless liquid, which had an odor resembling that of para cresol. The mean boiling point was 207.1°C. (corrected) at 0 millimeter pressure. The yield was 15.5 grams, or 42 per cent of the theoretical yield.

Analysis gave the following results:

	Carbon.	Hydrogen.
	Per cent.	Per cent.
Calculated for $C_{25}H_{38}O_2$	81.08	10.27
Found	80.07	11.66

The percentage of carbon and hydrogen obtained by analysis of this ester did not agree quite so well with the calculated percentage of carbon and hydrogen. Although we made a special effort to purify this ester, it probably contained a small quantity of some impurity. The absence of free cresol was determined by the ferric chloride color test. To ascertain if we had really prepared an ester, a small quantity was saponified with alcoholic potassium hydroxide. The excess alcohol was removed by distilling. The residue was then acidified with dilute sulphuric acid and steam distilled. When the distillate was tested with ferric chloride solution a characteristic blue color was formed showing the presence of para cresol. The chaulmoogric acid in the residue was crystallized from alcohol (95 per cent) and identified by a melting-point determination.

META CRESOL ESTER OF CHAULMOOGRIC ACID



The meta cresol ester of chaulmoogric acid was prepared from meta cresol and chaulmoogric acid. The procedure was the same as that used in preparing the ortho cresol ester.

The materials were mixed in the proportion of 30 grams of chaulmoogric acid to 13 grams of meta cresol, after which 9 grams of phosphorus oxychloride were added. The meta cresol ester was a colorless liquid which had a cresol-like odor. The mean boiling point was 207.4°C. (corrected) at 0 millimeter pressure. The yield was 16 grams, which is 40 per cent of the theoretical yield.

Analysis gave the following results:

	Carbon.	Hydrogen.
	Per cent.	Per cent.
Calculated for $C_{25}H_{38}O_2$	81.08	10.27
Found	80.33	11.34

The various esters we prepared are now being tested by Dr. O. Schöbl, chief of the division of biology and serum laboratory, Bureau of Science, Manila.

SUMMARY

The capryl and allyl esters of chaulmoogric acid were made by treating chaulmoogric acid with capryl and allyl alcohols, respectively, in the presence of hydrogen chloride gas.

The phenyl, ortho cresol, meta cresol, and para cresol esters of chaulmoogric acid were prepared by treating chaulmoogric acid with the proper phenol compound in the presence of phosphorus oxychloride.

ACKNOWLEDGMENT

Thanks are due Miss Paz Soriano, of the department of chemistry, University of the Philippines, for assistance in making the analyses.

THE RELATION OF TEMPERATURE AND MOISTURE TO DISEASED AND DISEASE-FREE CORN [1]

By TORIBIO VIBAR

Of the College of Agriculture, University of the Philippines, Los Baños, Laguna

ONE PLATE AND ELEVEN TEXT FIGURES

INTRODUCTION

THE PROBLEM

Diseased and disease-free corn were used in this work. By diseased corn is meant corn that showed fungous infection when dissected or tested in the seed germinator; and disease-free corn, corn that was free of fungous infection when similarly tested. Two lines of experiments were conducted; one in the laboratory, the other in the field. In the laboratory experiments, only *Diplodia* composite kernels were used, and in the field experiments, *Diplodia, Fusarium,* and scutellum-rot kernels. Therefore, diseased kernels (or seeds as used in this paper) may mean kernels or seeds chiefly infected with *Diplodia zeae* (Schw.) Lev., or may mean kernels or seeds, the chief infection of which is *Fusarium moniliforme* or scutellum rot. Scutellum rot is characterized by the blackening of the scutellum and consequent rotting of the embryo and the seed. Its cause is not yet well known.

The words "diseased" and "disease-free," used throughout this paper for lack of a better terminology, are misleading. Diseased kernels (and, consequently, diseased seedlings and plants) simply mean kernels taken from ears showing fungous infection in the germinator. There are, of course, kernels on the infected ears that may not be diseased or infected at all, in the ordinary sense of the word. Disease-free kernels are kernels from ears that were free of fungous infection. This does not mean that seedlings from disease-free kernels are not subject to infection

[1] Thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Agronomy in the graduate school of the University of Illinois, 1923.

in the period of their development later. In the use of diseased and disease-free kernels for experimental purposes, it is, however, certain at the beginning of the experiment that a certain organism is present among the kernels of the diseased, and absent among the kernels of the disease-free.

The loss of corn from corn diseases in the United States in 1919 exceeded 200,000,000 bushels, as estimated by the Plant Disease Survey Bureau of the United States Department of Agriculture.(23) Holbert and Hoffer(13) place this loss at 125,175,000 bushels, which is 4 per cent of the total crop. In 1921, the loss of corn from fungous diseases in Illinois was 10 per cent of the total crop;(36) in Indiana, Ohio, and Kentucky, it was 12 per cent. In Delaware(23) the loss was placed formerly at 3 to 5 per cent, but recent estimates have shown that this estimate was too low, and that the loss was about 15 per cent in 1920. The damage to corn caused by fungous diseases in the United States, as estimated by the plant pathologists of the country,(24) has increased from 6.39 per cent of the total crop in 1920 to 8.8 per cent in 1921.

Much study has been done on the relation of environmental factors to germination of seed and to growth and yield of crops. During the past decade, considerable emphasis has been laid on the study of plant diseases. In general, the object of the studies has been to find the effect of one or more factors of environment either on the crop alone or on the disease. The studies on the interrelation between plants and parasites as affected by the factors of environment simultaneously are very few.

PAST WORK

Effect of temperature and moisture on the germination of seeds.—Sachs(31) showed the dependence of seed germination and growth on temperature and the difference in the cardinal temperatures for the germination and growth of different species of plants. De Candolle found the same thing regarding cardinal temperatures for the germination of seeds of different species, and further demonstrated the reduction of the period required for germination as the temperature was raised. Bailey (3) reported that the lowering of temperature was correlated with the decrease in sprouting, that a constant temperature was more favorable to sprouting than a variable one of the same mean; that a comparatively small amount of water gave better results; and that soaking the seed had no influence upon sprout-

ing. Harrington(11) showed that some kinds of seeds germinate better at alternating temperatures, and other kinds germinate as well at favorable constant temperatures as with an alternation of temperatures. Reynolds(30) and Kinzel(17) arrived at the same conclusion; namely, that the cardinal temperatures for the germination of different kinds of seeds differ, and that the higher the temperature, the less time it would take seeds to germinate.

Effect of temperature and moisture on growth.—The work of Koppen(19) on the effect of temperature on the growth of corn, that of Leitch(21) on the relation of temperature to the growth of the roots of peas, and that of Lehenbauer(20) on the growth of maize seedlings as related to temperature have shown that there are a minimum, an optimum, and a maximum temperature for growth. Lehenbauer(20) has very conclusively demonstrated that the period of observation is a very important factor in determining the temperature optimum as related to plant growth. In a field study, Brown and Garrison(8) found that, as seeding was delayed, there was a very decided increase in the rapidity of germination and rate of growth of corn. Shibata(32) showed that the growth of bamboo in Japan is closely associated with the temperature of the air. Lock,(22) on the other hand, demonstrated that in Ceylon the growth of giant bamboos is more closely associated with the humidity of the air than with the temperature. Patterson,(26) however, in his work on the effect of relative humidity and temperature on the growth of bean seedlings, concluded that the humidity of the air has no controlling influence on growth as long as the moisture of the soil is sufficient for the needs of the plant.

Effect of temperature and moisture on the yield of crops.—Hessling(12) states that the yield of corn in Argentina is positively associated with the rainfall, but negatively correlated with the temperature. Blair(6) found the same relationship between rainfall and temperature and the yield of spring wheat in the Dakotas. Smith(34) found that in Ohio the yield of corn is largely determined by the July and August rains, the half-inch rain, falling ten or twenty days before blossoming, being the most important. Following the same line of investigation, Wallace(38) expressed the idea that, while the July and August rains are the most important factor in determining the yield of corn in Ohio, they are not so in Iowa, and that each state or, rather, each county has its own specific problem regarding moisture requirement for corn.

Effect of temperature and moisture on the development of fungous diseases.—Johann and others(14) found that *Diplodia zeae* (Schw.) Lev. attacks corn seedlings under very high and very low moisture conditions at temperatures of from 24 to 32° C. They state that at 28° C., when the soil was wet, 63 per cent of the plants showed severe browning of the mesocotyles. Norton(25) found the fungus causing the swelling disease of peach to become more active as soon as the severity of the winter was over, and held that the epidemic caused by this disease is regulated by the rains and dampness of the summer months. Weston(39) concluded from his work on the Philippine downy mildew of corn that the conidia of this fungus are produced only at night when the leaves are covered with a layer of moisture. Stevens(35) found that the development of *Endothia parasitica* has no relation to the amount and frequency of rainfall, but that the growth of this fungus is closely connected with the duration of favorable temperatures for growth. Balls(4) maintains that the rate of growth of the hyphæ of the sore-shin fungus is in accordance with Van't Hoff's Law. Klèbs,(18) Ames,(2) Brooks and Cooley,(7) Reddick,(29) Gilman,(10) Jones and Tisdale,(15) Peltier,(28) and Melhus and Durrel(24) have shown that there are a minimum, an optimum, and a maximum temperature for the development of fungi causing plant diseases, and that the cardinal temperatures for the development of these fungi vary with the kind.

OBJECT OF THE PRESENT WORK

Of the two sets of experiments reported here one set was conducted in the laboratory, and the other set in the field. The work pursued covered the effect of temperature, moisture, gases, and dry heat on diseased and disease-free corn and the effect of temperature, hydrogen ion concentration, and gases on pure cultures of *Diplodia zeae* (Schw.) Lev. In this paper, only the effect of temperature and moisture on diseased and disease-free corn is discussed, the other parts of the work being reserved for future publication.

TIME AND PLACE OF THE PRESENT WORK

The present work was conducted in the University of Illinois, the laboratory part of it in the plant physiology laboratory, during the latter part of the college year 1921–1922 and the early part of the college year 1922–1923. The field observations

were made in the summer of 1922 from the plantings made by the division of crop production of the agronomy department on the south farm.

MATERIALS AND METHODS

THE LABORATORY EXPERIMENTS

The kernels used for these experiments were taken from the harvest of the previous year; the diseased and the disease-free kernels were preserved in glass jars. As germinating media, rag dolls, brown silt loam, and sand were used. In the experiments where sand or soil was used, the percentage of moisture means the percentage of saturation, the maximum amount of water the sand or the soil can hold after the excess has been drained off being taken as 100 per cent. The temperature chambers used for the laboratory experiments are cases fitted with triple glass walls. The temperature in these cases is maintained to within 0.5° C. In these experiments, the period covered only the germination of the kernels and the growth of the seedlings. For the sake of a more comprehensive comparison, it was necessary to adopt relative figures in determining the differences in the growth of the fungus as affected by temperature; 100 represents development of mycelium covering the kernels entirely and spreading extensively; 50, medium development; 10, slight; 5, very slight; 2.5, negligible; and 0, no development. The particular methods of procedure will be discussed in the report of each experiment.

THE FIELD EXPERIMENTS

The corn used for the experiments was planted on plot north 200 of the agronomy field on the south farm. This field slopes southward gently, and is divided into east and west plots. The east plots were fertilized with 45 tons of well-rotted manure, 1.5 tons of lime, and 1,500 pounds of rock phosphate per acre, applied every three years before the potato crop in the rotation, which is potatoes, sweet clover, and corn. All the plots were treated alike throughout the course of the experiment. Four plantings were made, on May 4, May 13, May 22, and May 31. In each planting there were at least three rows, 8 rods long, of each kind of diseased and disease-free corn planted 75 inches in all directions with two kernels to the hill. Every alternate plot was a check plot; that is, a plot planted to disease-free corn. Records were made of the rate of growth, final

heights of plants, production of suckers and brace roots, leaning and fallen plants, yield, and smut infection of diseased and disease-free corn.

THE GROWTH MEASUREMENTS

A good index of growth is the weight of the plant. As this index cannot be used to indicate the growth of the plant at different stages of development, it is necessary to use an external character of the plant to measure growth. Some of these external characters are the height to the tip of the longest leaf, the height to the tip of the youngest leaf, and the height to the highest leaf base. Large numbers of seedlings were grown in the laboratory under uniform conditions. Every week, for five weeks after the kernels were planted, several seedlings were harvested, weighed individually, and the external characters mentioned determined. It was found that the height to the tip of the longest leaf was more closely correlated with the weight of the plant than was any other character measured. No difficulty, either in the field or in the laboratory, was encountered in measuring this character; but attempts to measure from a fixed point at the base of the plant to the highest leaf base or to the tip of the youngest leaf were met by unusual difficulties. The height of the highest leaf base does not increase fast enough, especially in the early development of the plant, in proportion to the mass of growth. The height to the tip of the youngest leaf cannot be safely relied upon, as many young leaves emerge together, especially in the late planting. It was further found that sometimes the height to the tip of the youngest leaf was less than the height to the tip of the young one in the previous measurement. It was, therefore, decided that, as a criterion of growth, the height to the tip of the longest leaf should be used. Pearl and Surface(27) used this method in their work on the growth and variation in corn.

THE CLIMATIC RECORDS

Records of the air temperature and of the soil temperature at different depths in the field were made. The temperature of the air was very variable, as was also the temperature close to the surface of the soil. The temperature at depths of 6, 12, and 24 inches was less subject to variation. That at a depth of 24 inches was practically unaffected by the fluctuation of the temperature of the air. It rose steadily in a straight line as the season advanced. In the study on the relation of tem-

perature (minimum, mean, and maximum), rainfall, and relative humidity of the air to growth, the climatic records taken by the College of Agriculture and Experiment Station were found more reliable and convenient, and were, therefore, used generally.

EXPERIMENTS AND RESULTS

THE LABORATORY EXPERIMENTS

a. Germination and growth of diseased and disease-free corn as affected by temperature.—Ten diseased kernels and ten disease-free kernels were placed in a rag doll, the diseased kernels on the left side of the rag doll and the disease-free kernels on the right side, about 8 inches from each other (Plate 1). After the dolls were rolled on wire cores, they were placed in a pan of water to soak for about three minutes. Then they were transferred to 2-gallon fruit jars loosely covered, and the jars were placed in the different temperature chambers, duplicate jars to each chamber. A set of two jars was kept at room temperature. After one week, the dolls were taken out of the different temperature chambers and the percentage of germination, the growth of the seedlings, the relative growth of the mycelium of the fungus, and the number of seeds and seedlings that had rotted determined. The average percentages of germination were 85, 85, 85, 70, 90, and 80 for the diseased kernels, and 100, 100, 90, 95, 90, and 95 for the disease-free kernels at the 30, 25, room, 20, 15, and 10° C. temperatures, respectively. In the same temperature order, the average lengths of the plumules, in millimeters, were 133.5, 134.5, 101.5, 96, 34.5, and 8.2 for the diseased kernels, and 189.5, 166.5, 139.5, 98.5, 35.5, and 9.8 for the disease-free kernels. The relative development of the mycelium was 100, 100, 95, 65, 15, and 7.5 on the diseased kernels, and 45, 27.5, 40, 20, 2.5, and 1.2 on the disease-free kernels. The numbers of kernels and seedlings that had rotted were 10, 10, 10, 7.5, 2, and 2 of the diseased, and 5, 2, 3.5, 2, 0.5, and 0 of the disease-free kernels, respectively. *Diplodia* constituted practically all the fungous growth on the diseased kernels, and *Rhizopus* on the disease-free. The illustration, Plate 1, shows the results of exactly the same kind of experiment as this one, but the kernels used were taken from the 1922 harvest on the south farm. Rise in temperature increases the rate of growth of diseased and disease-free corn and the development of the *Diplodia* mycelium. More kernels and seedlings rot at higher temperatures.

b. Effect of fluctuating temperatures on diseased and disease-free corn.—Another series of dolls was prepared and subjected to fluctuating temperatures. Two sets of duplicate dolls were exposed at 30 to 20° C. and at 20 to 30° C.; that is, the set exposed at the 30 to 20° C. was first placed in the 30° C. chamber, and the set exposed at the 20 to 30° C. was first placed in the 20° C. chamber. The dolls then were shifted from one temperature chamber to the other every twenty-four hours for eight days. Other sets of dolls were subjected to 25 to 15° C., 15 to 25° C., 20 to 10° C., and 10 to 20° C. As can be seen, these fluctuating temperatures give means of 25, 20, and 15° C., respectively. To compare the effect of these fluctuating temperatures with the effect of uniform temperature of the same mean, the dolls in the 25, 20, and 15° C. chambers in the previous experiment were returned to their respective chambers for one more day after the record was taken, in order that the length of their exposures to these temperatures might be the same as that at the fluctuating temperatures. After eight days, the dolls were taken out and records taken as before. The average percentages of germination in the 30 to 20, 20 to 30, 25, 25 to 15, 15 to 25, 20, 20 to 10, 10 to 20, and 15° C. were 80, 90, 85, 75, 75, 70, 75, 75, and 85 for the diseased kernels, and 100, 95, 100, 95, 100, 90, 90, 100, and 95 for the disease-free kernels, respectively. At the same temperature order, the average lengths of the plumules, in millimeters, were 69, 71, 143, 71, 43, 104, 7.5, 7.5, and 50 for the diseased kernels, and 82, 91, 169, 88, 69, 159, 7.5, 7.5, and 46 for the disease-free. The relative growth of the mycelium of the fungus was 90, 100, 100, 70, 75, 65, 15, 10, and 15 on the diseased kernels, and 7.5, 50, 35, 20, 25, 20, 2.5, 2.5, and 3.7 on the disease-free kernels. The numbers of the kernels that rotted were 6, 10, 10, 5.5, 9, 9, 4, 2, and 2 for the diseased kernels, and 0.5, 5.5, 4.5, 1.5, 3.5, 3.5, 0, 0.5, and 1 for the disease-free kernels, respectively. The same results were obtained in this experiment regarding the relation of temperature to the rate of growth of diseased and disease-free corn, the development of *Diplodia* mycelium, and the number of kernels and seedlings that rotted. Uniform temperature is more favorable to growth of corn than is alternating temperature of the same mean.

Another experiment was conducted to determine the effect of fluctuating temperatures. Diseased and disease-free kernels were planted in sand containing 20, 40, and 60 per cent water.

Petri dishes of 175 cubic centimeters capacity were used as containers. They were placed under inverted fruit jars of 2 liters capacity. One diseased kernel and one disease-free kernel were planted in each dish 1.5 inches from each other. To simulate the diurnal change of temperature, the cultures were placed in the 30° C. chamber in the daytime. At night, they were placed, respectively, in the 10, 15, 20, and 25° C. chambers. One set of cultures was kept at 30° C. None of the diseased kernels germinated. After one week, the heights of the disease-free seedlings were measured, showing the results presented in Table 1.

TABLE 1.—*Effect of fluctuating temperature on the growth of disease-free corn.*

Temperature.	Percentage of moisture.		
	20	40	60
°C.	*mm.*	*mm.*[a]	*mm.*
30 [a]	250	282	320
30 to 25	128	238	251
30 to 20	90	140	156
30 to 15	33	95	141
30 to 10	31	50	58

[a] Constant.

The roots were carefully washed. No infection above or below the surface of the sand was noted. The diseased kernels that failed to germinate were covered with *Diplodia* mycelium chiefly. The mass of the mycelium growing on the surface of the sand above the diseased kernels is shown by the comparison presented in Table 2.

TABLE 2.—*Effect of fluctuating temperature on the development of Diplodia mycelium.*

Temperature.	Percentage of moisture.		
	20	40	60
°C.			
30 [a]	Slight	Not much	Much.
30 to 25	do	Much	Do.
30 to 20	None	None	Slight.
30 to 15	do	Slight	Do.
30 to 10	do	None	None.

[a] Constant.

In this experiment a higher rate of growth of seedlings was obtained at high temperature and high moisture condition, as shown in Table 1. The rate of development of *Diplodia* mycelium as related to temperature and moisture parallels the rate of growth of the seedlings generally, as shown in Table 2.

c. Germination and growth of diseased and disease-free corn, as affected by different amounts of water.—Four galvanized iron pans, 12 inches long, 5 inches wide, and 6 inches deep, were half filled with a moist mixture of sand and sphagnum. Two hundred cubic centimeters of water were added to pan 2, 400 cubic centimeters to pan 3, and 800 cubic centimeters to pan 4. Pan 1 received no additional water. Pan 1 was moist and pan 4 was wet. The moisture content of the sand and sphagnum in pans 2 and 3 was intermediate. The moisture content of the four pans was kept constant by replacing every Monday, Wednesday, Friday, and Saturday the water lost through evaporation and transpiration. In each pan five diseased kernels were planted at one end and five disease-free kernels at the other. The pans were kept under greenhouse conditions throughout the experiment. No germination took place in the first three days after planting. The numbers of diseased kernels that germinated were 5, 3, 5, and 3, and the numbers of disease-free kernels were 5, 5, 4, and 5 in pans 1, 2, 3, and 4, respectively. All the seedlings in pans 1, 2, and 3 emerged on the fourth day. Those in pan 4 did not all emerge until the fifth day. Growth measurements were taken every Monday, Wednesday, and Friday for thirty days, at the end of which time the average heights of the seedlings from the diseased kernels were 655, 582, 633, and 603 millimeters, and those from the disease-free kernels were 639, 598, 695, and 556 millimeters in pans 1, 2, 3, and 4, respectively. Practically no difference was observed in the rate of germination of diseased and disease-free kernels, and in the rate of growth of diseased and disease-free seedlings. High moisture condition in the germinating media retarded germination decidedly.

d. Effect of diseased kernels on disease-free kernels as affected by temperature and moisture.—Three diseased kernels and three disease-free kernels were planted in tall preserving jars. Sand containing 20, 40, and 60 per cent moisture was used. The jars were kept in the different temperature chambers for one week, except those in the 10° C. case, which had to be kept in that case for a month because of slow germination and growth. All the disease-free kernels germinated at 10 to 30° C. in the 20, 40, and

60 per cent moisture cultures. Of the diseased kernels, one seed germinated at 30° C., none at 25° C., one at 20° C., two at 15° C., and two at 10° C. In the 40 per cent moisture, two, one, one, none, and two kernels germinated; and in the 60 per cent moisture, two, one, two, two, and two kernels germinated in the 30, 25, 20, 15, and 10° C. chambers, respectively. The kernels that failed to germinate were taken out and examined. The diseased kernels had rotted and were covered with *Diplodia* mycelium. All the seedlings from the disease-free kernels at 30 and 25° C. in the sand containing 20, 40, and 60 per cent water were infected except one in the 60 per cent moisture. At 20° C. only one seedling was infected in the 20 per cent moisture, and none in the 40 or the 60 per cent. The seedlings at the 15 and the 10° C. were found free of infection. Infection in all cases took place in the mesocotyle, which is very tender and soft.

The diseased kernels covered with mycelium in the experiment immediately preceding were planted in fresh sand saturated to 20, 40, and 60 per cent of its water-holding capacity. One dead kernel was planted in each jar. One diseased kernel was planted at one side of this dead kernel and one disease-free kernel at the opposite side. The cultures were placed in the different temperature chambers for one week. None of the diseased kernels germinated. All the disease-free kernels germinated and grew. The shoots of the seedlings of the disease-free kernels were measured at the end of the experiment and gave the results presented in Table 3.

TABLE 3.—*Effect of uniform temperature on the growth of disease-free corn.*

Temperature.	Percentage of moisture.		
	20	40	60
°C.	mm.	mm.	mm.
30	227	228	294
25	84	154	251
20	88	94	112
15	42	72	100
10 [a]	32	49	58

[a] One month.

On the surface of the sand above the diseased kernels, *Diplodia* mycelium developed. The relative extent of this development, taking 100 as the greatest, can be seen by the comparison presented in Table 4.

TABLE 4.—*Effect of uniform temperature on the relative development of Diplodia mycelium.*

Temperature.	Percentage of moisture.		
	20	40	60
°C.			
30	10	25	0
25	50	100	60
20	0	5	10
15	0	2	2
10 [a]	0	0	0

[a] One month.

It is significant in this connection that no infection of the seedlings from the disease-free kernels took place in one week at 30, 25, 20, and 15° C. and during one month at 10° C. in spite of their contact with the diseased, rotted kernels.

e. Germination and growth of diseased kernels of different degrees of infection.—Every alternate kernel from the butt to the tip of an ear infected with *Diplodia* was planted in sand containing 50 per cent moisture. The germinating pan was kept covered for one week. At the end of one week it was necessary to uncover the pan in order to allow the seedlings to grow freely. From one row, twenty-four kernels were planted in the sand and from the other row, twenty-three kernels. The kernels were numbered consecutively from the tip of the ear. The seedlings were allowed to grow for seventeen days. Kernels 1 to 13 in the first row, and kernels 1 to 14 in the other row, failed to germinate. Kernels 14 and 15 in the first row germinated; the seedlings grew for a few days, and then succumbed to *Diplodia*. The seedling from kernel 15 in the other row attained a height of 15 millimeters, and died on the fourteenth day after planting. The total heights reached by the seedlings from kernels 16, 17, 18, 19, 20, 21, 22, 23, and 24 were 285, 295, 275, 265, 265, 253, 320, 254, and 310 millimeters, respectively, for the first row, and 255, 295, 245, 233, 236, 225, 250, and 240 millimeters for the second row. The seedlings were apparently growing normally when the experiment was closed. The result of this experiment shows that infection of *Diplodia* was confined to the kernels at the tip end, and that the degree of infection of the kernels varies.

f. Effect of temperature on the germination and growth of corn of different degrees of infection.—After the extreme tip and

butt kernels had been removed, the kernels from an ear of corn infected with *Diplodia* were placed in rag dolls, one row of forty seeds to each rag doll. The kernels were numbered consecutively from the tip of the ear, and were placed in the rag doll in the same order as when on the ear. After the seeds had been rolled in the rag dolls, the dolls were placed in a pan of water to soak for about three minutes and then transferred to loosely covered Mason jars and placed in the different temperature chambers, two jars to each chamber. A set of two jars was kept at room temperature. After one week the dolls were opened, and record of the growth of the seedlings and of the fungus was taken. The experiments in the 30, 25, room, and 20° C. temperatures were closed at the end of one week. The experiment in the 15° C. was allowed to run for two weeks, and that in the 10° C. for four weeks. The average percentages of germination at the 30, 25, room, 20, 15, and 10° C. temperatures were 61, 54, 60, 68, 68, and 67, respectively. The relative mycelial development was 100 at 30° C., 97.5 at 25° C., 90 at room temperature, and 85 at 20° C. for one week. At 15° C. the mycelial development was 25 in the first week and 97.5 at the end of the second week. At 10° C. in one week only two kernels in each rag doll germinated. The development of the *Diplodia* mycelium was visible at this temperature for the same period. At the end of two weeks, the length of the plumules of the kernels that germinated at 10° C. averaged only about 5 millimeters, and the relative mycelial development was about 20. At the end of the third week, the seedlings had not made much progress at this temperature, but the mycelium showed considerable development, in some cases covering whole seeds. Only eleven seedlings in one rag doll had not rotted, and nine in the other. At the end of four weeks the relative mycelial development was about 70. Seeds and seedlings 1 to 33 had rotted. Only the growth of seedlings 34 to 40 was measured, as these seedlings were the only ones showing normal development. The average length of these seedlings was 12 millimeters. The numbers of seeds and seedlings that had rotted in one week in the 30, 25, room, and 20° C. temperature were 40, 34.5, 35, and 26.5, respectively. At 15° C. the number was 25.5 at the end of the first week and 35.5 at the end of the second week. At 10° C. twenty-three seeds and seedlings rotted at the end of the second week, and thirty-three at the end of the fourth week. *Diplodia* infection takes place at temperatures of from 10 to 30° C. The infection is more severe at

higher temperatures. At 10° C. *Diplodia* mycelium develops faster than the corn.

g. Effect of moisture on the germination and growth of corn of different degrees of infection.—Kernels from the same ear as that used in the experiment immediately preceding were planted in moist and wet soil 2.5 inches apart, and the rows 5 inches apart with 10 kernels to the row. The kernels were planted in the soil in the same order as when in the rows on the ear. Two rows of kernels were planted in the moist soil and two rows in the wet soil. The moisture of the soil was maintained by watering at least once a day. The seedlings showed little development at the end of the first week. Measurement of growth was started at the end of the second week from the planting time, and continued every week thereafter. Fifty-seven per cent was the average of germination of the kernels in the moist soil, and 53 per cent that of kernels in the wet soil. Practically all the kernels that failed to germinate were the ones from the tip to the middle of the ear. With the exception of three or four kernels, all the kernels from the butt end to the middle of the ear germinated, and grew normally for six weeks. Some kernels from the tip end to the middle of the ear germinated. About four in each row developed normally, as did the kernels at the butt. Some seedlings succumbed just after germination; others attained a height of a few millimeters, withered, and died or rotted; the diseased seedlings in the moist soil withered and died and those in the wet soil rotted. Apparently the death of the seedlings occurred earlier in the wet soil than in the moist soil. There was practically no difference in the height reached by the seedlings in the moist and in the wet soil at the end of the experiment.

h. Rate of germination of disease-free corn as affected by temperature and moisture.—Brown silt loam soil taken from the south farm was used as the medium, Yellow Dent Corn 176–A as subject, and jelly glasses of 200 cubic centimeters capacity as containers. Different portions of soil were saturated to 10, 20, 30, and 40 per cent of their water-holding capacity, respectively. The soil was then transferred to the container, and compacted with the compacting machine to give the different cultures the same degree of compactness. Five kernels were planted in each of duplicate cultures, and the cultures were then placed in the different temperature chambers. A set of cultures was kept at room temperature. Effort was made to minimize the loss of water through evaporation by transferring the soil to sealed

containers while the compacting was going on. Observation on the rapidity of germination was made daily. No kernels germinated in the soil containing 10 per cent moisture at any of the temperatures tested. In the soil containing 20 per cent moisture no kernels germinated at 10° C.; at 15° C. 10 per cent of the kernels germinated in fourteen days and 20 per cent in twenty-one days; at 20° C. 10 per cent of the kernels germinated in five days, 20 per cent in twenty-one days, and 30 per cent in twenty-eight days; at room temperature 30 per cent of the kernels germinated in six days, 60 per cent in fourteen days, and 70 per cent in twenty-one days; at 30° C. 70 per cent germinated in five days and 80 per cent in six days. In the soil containing 30 per cent moisture, at 10° C. 20 per cent of the kernels germinated in fourteen days, 60 per cent in twenty-one days, and 70 per cent in forty-two days; at 15° C. 80 per cent of the kernels germinated in fourteen days and 100 per cent in twenty-one days; at 20° C. 20 per cent of the kernels germinated in four days, 90 per cent in five days, and 100 per cent in seven days; at room temperature 30 per cent of the kernels germinated in three days and 100 per cent in four days; and at 30° C. the germination of the seed was 100 per cent in three days. In the soil containing 40 per cent moisture, at 10° C. 40 per cent of the kernels germinated in twenty-one days, 70 per cent in twenty-eight days, 80 per cent in thirty-five days, and 90 per cent in forty-two days; at 15° C. 20 per cent germinated in seven days and 100 per cent in fourteen days; at 20° C. 50 per cent germinated in four days and 100 per cent in five days; at room temperature 30 per cent germinated in three days and 100 per cent in four days; and at 30° C. 100 per cent of the kernels germinated in three days. Twenty per cent, therefore, is the critical moisture content of brown silt loam. At this saturation, the kernels cannot germinate at 10° C., but at 15 to 30° C. more and more kernels are able to take water from the soil and germinate as the temperature rises. The rapidity of the rate of germination caused by high temperature is very evident from the experiment. Water also plays an important part. At the same temperature, increase in the moisture content of the soil, as far as this experiment is concerned, also accelerated and increased the rate of germination. In this experiment, the point of germination was taken when the plumule emerged on the surface of the soil. In the cultures containing a low percentage of moisture, especially those at lower temperatures, some seeds germinated but failed to come up. These seeds were all covered

with mycelium. At the end of each experiment, the average heights of the seedlings were taken. These average heights were found to be as shown in Table 5.

TABLE 5.—*Effect of temperature and moisture on the growth of corn seedlings.*

Temperature.	Age of seedlings.	Moisture of culture.	Height of seedlings.
°C.	*Days.*	*Per cent.*	cm.
10	19	30	2.70
10	19	40	4.35
15	29	30	2.22
15	29	40	6.79
20	11	30	5.64
20	11	40	8.29
Room	8	20	0.40
Room	8	30	6.43
Room	8	40	10.16
30	10	20	5.29
30	10	30	10.94
30	10	40	13.92

Table 5 shows that the effect of moisture on the growth of the seedlings is as significant as is the effect of temperature.

i. Rate of germination of diseased corn as affected by temperature and moisture.—Three lots of sterilized white quartz sand were moistened to 20, 40, and 60 per cent of their water-holding capacity, respectively. The sand was then transferred to Petri dishes of 250 cubic centimeters capacity. Five diseased kernels were planted in each dish, and the cultures were placed in the different temperature chambers. Observation on the rate of germination was made daily. In the cultures containing 20 per cent moisture, at 10° C. 40 per cent of the kernels germinated in fourteen days. No further germination took place after fourteen days. At 15° C. 40 per cent of the kernels germinated in five days; at 20° C. also 40 per cent of the kernels germinated in five days; at 25° C. 80 per cent of the kernels germinated in three days; and at 30° C. 60 per cent of the kernels germinated in three days. In the cultures containing 40 per cent moisture, 20 per cent of the kernels germinated in fourteen days at 10° C.; at 15° C. 20 per cent germinated in five days; at 20° C. 40 per cent germinated in three days; and at 30° C. 60 per cent germinated in three days. In the cultures containing 60 per cent moisture, at 10° C. 40 per cent of the kernels germinated in fourteen days; at 15° C. 60 per cent in five days; at 20° C. 40

per cent in five days; at 25° C. 60 per cent in three days; and at 30° C. 60 per cent in three days. No further germination took place after the expiration of the number of days mentioned. The percentage of germination of *Diplodia* composite kernels is very low in this experiment; it was always so in all the experiments where this kind of kernel was used. In this experiment, while rise in temperature reduced the period required for germination, the results show that it had no decided effect in increasing the percentage of germination.

In all the laboratory experiments, rise in temperature increased the rapidity of germination and the rate of growth of the seedlings, both of diseased and of disease-free corn. In the sand and soil cultures, increase in moisture gave significant increases in the rate of growth of the seedlings, as far as the experiments reported herein are concerned. High moisture condition in the germinating media retarded germination slightly. This retardation was especially significant in the cultures at low temperatures. Neither temperature nor moisture seems to have any effect on the percentage of germination. The development of *Diplodia* mycelium is also increased by the rise in temperature. The number of seeds and seedlings rotting is large at high temperatures. High moisture condition generally favored the development of *Diplodia*.

FIELD EXPERIMENTS

a. The effect of date of seeding on the growth of diseased and disease-free corn.—Twenty days after each planting, and until the plants ceased growing, growth measurements of plants on the diseased and the disease-free plots were taken. The measurements were made from a fixed point on the surface of the soil to the tip of the longest leaf. Measurements were also made to the tip of the tassel as soon as the tassels appeared. Twelve plants, picked at random, apparently representative of the plants in each plot, were measured, making seventy-two plants for each planting, and two hundred eighty-eight plants for all the plantings. All the plants, the growth of which were measured, were in the east plots. The growth measurements were made every third day in the afternoon, beginning at 1 o'clock. These growth measurements constitute one table of figures for each plot, six tables for each planting (three for diseased and three for disease-free corn), and twenty-four tables for all the plantings. The growth measurements of the plants

in each plot were averaged, reducing the number of tables to four, one table for each planting. Then the three-day growth increments were determined. As there were three checks in each planting, the average growth increments of the three checks were again averaged. Graphs were constructed from the growth increments; the relation of the growth increments to the rainfall, humidity of the air, and temperature of the air was determined and is discussed under the general discussion of the results of these experiments. For the sake of simplicity, the data are given in graphic form rather than in tables. (See figs. 3 to 11.

b. Yield of diseased and disease-free corn as affected by different dates of planting.—The crop was harvested by the division of crop production of the department of agronomy, and the yields of the different plots were determined. Table 6 shows the yields of the diseased and the disease-free corn of the plots where the growth measurements were taken. These plots are in the northeast section of plot north 200. They are a part of a much larger plot devoted to investigation on the effect of dates of seeding on diseased and disease-free corn. In Table 7 are given the average yields of all the plots under this investigation.

TABLE 6.—*Effect of date of seeding on the yield of diseased and disease-free corn (northeast plots).*

Kind of seed.	Yield in east plots.	Yield in west plots.
	Bu.	*Bu.*
Scutellum rot:		
First planting	56.9	50.5
Second planting	46.1	44.4
Third planting	42.8	40.4
Fourth planting	39.4	36.3
Diplodia:		
First planting	40.9	43.5
Second planting	30.4	38.8
Third planting	31.3	34.7
Fourth planting	24.5	24.4
Fusarium:		
First planting	54.7	51.9
Second planting	48.4	50.7
Third planting	49.4	44.8
Fourth planting	44.0	39.0
Disease-free:		
First planting	60.9	56.2
Second planting	54.1	51.5
Third planting	56.0	51.0
Fourth planting	47.5	43.7

TABLE 7.—*Effect of date of seeding on the yield of diseased and disease-free corn (all plots).*

Kind of seed.	Yield in east plots.	Yield in west plots.
	Bu.	*Bu.*
Scutellum rot:		
First planting	63.9	54.7
Second planting	54.3	55.5
Third planting	48.2	44.5
Fourth planting	47.5	40.0
Diplodia:		
First planting	43.9	40.9
Second planting	35.5	36.9
Third planting	33.9	35.7
Fourth planting	33.5	29.5
Fusarium:		
First planting	57.6	48.6
Second planting	54.1	54.5
Third planting	52.0	49.0
Fourth planting	54.3	44.1
Disease-free:		
First planting	65.6	52.6
Second planting	59.8	56.8
Third planting	59.2	53.1
Fourth planting	56.6	49.4

It will be noted from these two tables that there was a general reduction in yield in all the diseased and disease-free plots as the planting was delayed. The difference in yield between the second and the third plantings is not so significant as is that between the first and the last plantings. There was a more-significant reduction in yield on the *Diplodia* plots than on either the *Fusarium*, the scutellum rot, or the disease-free plots. This reduction in yield, as can be seen in Tables 6, 7, and 11, is due more to the reduction in stand of the plants than to the reduction in size of the individual ears. In general, the difference in yield between the east and the west plots is slight.

c. Effect of date of seeding on variability in height of diseased and disease-free corn.—In as much as it was not possible to measure the growth of all the plants in each plot in the east plots, the heights of practically all the plants in these plots were measured just after growth ceased. The mean, the standard deviation, the coefficient of variability of the heights of the plants measured, and the probable error of these constants were determined. These determinations are given in Table 8.

TABLE 8.—*Variability in height of diseased and disease-free corn.*

Condition of seed.	Mean.	Standard deviation.	Coefficient of variability.
	Inches.	*Inches.*	
FIRST PLANTING.			
Scutellum rot	101.73±.3574	7.12±.2563	6.99±.2521
Disease-free	102.80±.3170	6.06±.2181	5.89±.2124
Diplodia	104.40±.4486	8.17±.4565	7.82±.4422
Disease-free	103.17±.3170	6.28±.2260	6.08±.2188
Fusarium	104.10±.4114	8.19±.2948	7.86±.2829
Disease-free	101.73±.3439	6.82±.2447	6.80±.2484
SECOND PLANTING.			
Scutellum rot	102.54±.3586	7.03±.2530	5.52±.1987
Disease-free	104.77±.3163	6.20±.2232	5.91±.2127
Diplodia	101.96±.5965	8.88±.5949	8.17±.5829
Disease-free	104.76±.3275	6.42±.2311	6.12±.2203
Fusarium	101 81±.3678	7.20±.2592	7.07±.2535
Disease-free	103.31±.3299	6.45±.2330	6.24±.2248
THIRD PLANTING.			
Scutellum rot	102.73±.4076	8.13±.2926	7.91±.2847
Disease-free	103.95±.3612	7.08±.2548	7.77±.2797
Diplodia	103.46±.5183	7.86±.5115	7.60±.4940
Disease-free	104.61±.3544	6.92±.2491	6.61±.2379
Fusarium	105.54±.4030	7.90±.2848	7.84±.2822
Disease-free	104.17±.4418	8.66±.3117	8.31±.2991
FOURTH PLANTING.			
Scutellum rot	105.23±.4476	7.42±.4526	7.05±.4270
Disease-free	106.56±.4397	7.98± 4382	7.49±.4119
Diplodia	102.21±.6269	8.31± 6232	8.13±.6097
Disease-free	103.20±.4395	7.99±.4372	7.74±.4147
Fusarium	101.72±.4336	7.87±.4328	7.73±.4141
Disease-free	104.28±.4441	8.08± 4449	7.76±.5115

It appears from this table that the heights of the plants in the last two plantings have a greater variability than have those in the first two plantings. The diseased plants, especially the *Diplodia* plants, were more variable in height than were the disease-free plants. There is no consistent difference in the total heights reached by the diseased and the disease-free plants in the four plantings.

d. Indications of diseased condition; production of suckers and brace roots.—In corn, the production of suckers and brace roots, the curling of leaves, tip-burnt leaves, and deficient chlorophyll

production have been mentioned or assumed by investigators and farmers as indications of a diseased condition. The curling and the drying of leaves may indicate root destruction caused by root-rot diseases. A general survey and count of the plants with curling leaves in all the plots under observation showed that there were as many plants with curling leaves among the plants on the diseased as on the disease-free plots. A similar survey of the stalks toppling over gave the same results. While the curling and the drying of leaves and the toppling over of the stalks may indicate a diseased condition of the roots, it is believed that they cannot be taken as conclusive proofs of root attack by root-rot parasites, especially when the weather conditions are adverse to the development of the corn plant. This is also true of tip-burnt leaves and drying of the lower leaves. Tip-burnt leaves in the young stage may show not only root destruction, but also bacterial infection. A few plants on the diseased plots were observed to have been decidedly infected with root rot. The production of chlorophyll in all of these plants was imperfect. The leaves of these plants were characterized by long, white stripes and broken chlorophyll lines. There is a wide variation in the degree of greenness in the leaves of corn. Whether this phenomenon is due to heredity, to the influence of environment, or to disease remains to be learned.

At the time the plants ceased to grow, each plant in the east and the west plots was examined individually. The number of suckers produced by each plant was counted, as well as the number of plants producing brace roots on the first, second, third, fourth, and fifth nodes above the surface of the soil. Of the plants with suckers between 90 and 95 per cent had one or two suckers. Some produced three. Less than 1 per cent of the sucker-producing plants had four suckers. The plants on the *Diplodia* plots produced slightly more suckers than did the plants on the other diseased plots and on the disease-free plots. There was no significant difference between the number of plants producing suckers on the *Fusarium*, scutellum-rot, and the disease-free plots in any of the four plantings. About 90 per cent of the brace-root-producing plants had brace roots on the first, second, and third nodes above the surface of the soil. Very few plants had brace roots on the fourth node. In the east and the west plots there were only four plants found to produce brace roots on the fifth node. No significant difference was noted in the production of brace roots by plants on the diseased and on the disease-free plots in any of the four plant-

ings. In general, the leaning and fallen plants had more brace roots than did the erect ones. Table 9 gives the percentage of plants producing suckers and brace roots in the east plots, and Table 10 gives that for the plants in the west plots.

TABLE 9.—*Percentage of plants producing suckers and brace roots (east plots).*

Condition of seed.	Plants with suckers.		Plants with brace roots on second and upper nodes.	
	Erect.	Leaning and fallen.	Erect.	Leaning and fallen.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
FIRST PLANTING.				
Scutellum rot	37.83	30.64	46.00	52.22
Disease-free	41.72	29.72	30.07	56.75
Diplodia	45.05	49.12	40.30	71.92
Disease-free	28.85	41.17	37.27	60.00
Fusarium	38.83	31.30	30.45	59.13
Disease-free	40.11	31.94	18.60	43.05
SECOND PLANTING.				
Scutellum rot	46.16	30.37	60.13	78.48
Disease-free	47.96	45.00	56.09	74.16
Diplodia	60.22	100.00	59.09	66.66
Disease-free	44.68	45.45	60.29	87.14
Fusarium	44.74	38.52	43.85	70.49
Disease-free	49.65	39.53	61.46	82.94
THIRD PLANTING.				
Scutellum rot	44.44	40.00	56.71	38 57
Disease-free	38.41	28.76	50.99	82.19
Diplodia	64.70	47.30	35.29	68.42
Disease-free	40.90	29.62	46.10	85.18
Fusarium	47.95	47.05	50.87	61.76
Disease-free	48.80	51.28	51.61	64.10
FOURTH PLANTING.				
Scutellum rot	60.75	00.00	40.62	100.00
Disease-free	56.70	62.50	42.29	62.60
Diplodia	64.86	66.66	40.54	50.00
Disease-free	52.00	30.00	45.33	100.00
Fusarium	39.15	75.00	38.55	41.65
Disease-free	37.50	20.81	37.73	37.50

Examination of the figures in Tables 9 and 10 shows that no conclusive statement can be made regarding the difference in the production of suckers and brace roots by diseased and

by disease-free plants. Nor can any definite statement be made regarding the effect of planting on the production of suckers and brace roots.

TABLE 10.—*Percentage of plants producing suckers and brace roots (west plots).*

Condition of seed.	Plants with suckers.		Plants with brace roots on second and upper nodes.	
	Erect.	Leaning and fallen.	Erect.	Leaning and fallen.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
FIRST PLANTING.				
Scutellum rot	22.70	23.21	42.52	58.92
Disease-free	38.19	41.00	37.11	76.36
Diplodia	33.69	50.00	57.14	70.68
Disease-free	31.21	28.35	28.80	47.76
Fusarium	31.70	30.13	29.25	29.31
Disease-free	41.34	36.50	26.66	30.79
SECOND PLANTING.				
Scutellum rot	39.02	50.50	49.02	60.46
Disease-free	36.30	30.70	50.36	80.18
Diplodia	60.76	54.44	55.69	88.88
Disease-free	35.13	52.85	54.95	89.46
Fusarium	38.28	31.57	58.02	71.40
Disease-free	32.39	30.61	59.93	76.53
THIRD PLANTING.				
Scutellum rot	38.55	35.82	54.41	66 66
Disease-free	25.20	23.89	55.29	80.95
Diplodia	58.25	71.42	68.93	64.28
Disease-free	48.41	42.85	69.84	92.85
Fusarium	44.51	46.71	56.09	85.71
Disease-free	50.94	50.00	59.11	95.45
FOURTH PLANTING.				
Scutellum rot	69.56	83.33	60.00	54 16
Disease-free	41.33	47.36	70.00	68.42
Diplodia	60.00	57.14	73.33	90.47
Disease-free	51.29	33.33	63.63	66.66
Fusarium	45.90	32.00	43.44	54.00
Disease-free	40.86	27.47	52.17	64.70

e. Stand and leaning and fallen stalks.—At the same time as the plants in all the plots and plantings were being examined for suckers and brace roots, notes were taken on the number

of plants in each plot at maturity and the number of leaning and fallen stalks. Stalks that were decidedly bent by strong wind and stalks that were decidedly leaning were counted as leaning stalks. Plants, the stalks of which touched the ground, were counted as fallen plants. The percentage of stand and the percentage of leaning and fallen stalks were determined. The percentage of stand was obtained by dividing the number of plants on each plot at the time of observation by the total number of kernels planted. The percentage of leaning and fallen plants was obtained similarly. These percentages are given in Table 11. In this table will be noted the reduction of the percentage of stand as the seeding was delayed, and the greater number of leaning and fallen stalks in the first and the second plantings. The last planting had considerably fewer leaning and fallen stalks. The third planting had more than the last, and fewer than did either the first or the second planting. The first and the second plantings were hit by three storms, and the third and the last by one. There is no consistent difference in the number of leaning and fallen stalks among diseased and disease-free plants. There are other factors which cause stalks to lean and to fall besides root destruction by root-rot organisms. Among these causes can be mentioned shallow planting, looseness of the soil, and strong wind. The place of impact of the wind may further cause great differences in the number of leaning and fallen stalks in different parts of a field. A few days before and after tasseling, the stalks are easily bent by strong wind. It was observed that before and after this period the plants were not easily bent.

Table 11 shows that there was no perfect stand in any of the diseased and disease-free plots. The stand of the plants on the *Diplodia* plots was particularly low. A general reduction in the percentage of stand on all the plots took place as the seeding was delayed. This reduction was especially marked on the *Diplodia* plots. Reduction in stand is certainly an important factor in decreasing the yield of corn.

Examination of the figures in Table 11 shows that there is no significant difference in the percentage of leaning and fallen stalks on the diseased and on the disease-free plots. The leaning and falling of stalks is caused by so many factors that they cannot very well be taken as a condition showing root destruction by root-rot organisms.

f. Smut infection of diseased and disease-free corn.—The numbers of plants attacked by smut (killed and not killed) in the

TABLE 11.—*Percentage of stand and of leaning and fallen stalks*

Condition of seed.	East plots.		West plots.	
	Stand.	Leaning and fallen stalks.	Stand.	Leaning and fallen stalks.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
FIRST PLANTING.				
Scutellum rot	84.12	29.24	76.59	29.53
Disease-free	93.65	31.35	78.97	27.63
Diplodia	58.73	38.51	70.23	27.91
Disease-free	91.26	36.95	95.27	27.91
Fusarium	93.17	48.93	94.04	30.80
Disease-free	96.82	28.50	95.23	26.03
SECOND PLANTING.				
Scutellum rot	88.09	35.58	87.69	41.17
Disease-free	96.38	49.38	95.63	46.05
Diplodia	40.87	14.56	49.20	36.21
Disease-free	85.50	35.32	88.49	50.22
Fusarium	93.65	51.69	90.87	49.82
Disease-free	94.44	54.24	95.19	40.80
THIRD PLANTING.				
Scutellum rot	80.95	34.31	81.34	19.02
Disease-free	88.88	32.38	84.12	19.81
Diplodia	41.26	18.26	46.50	11.96
Disease-free	82.53	25.96	80.95	6.85
Fusarium	81.35	16.59	82.93	16.74
Disease-free	76.98	20.10	71.82	11.60
FOURTH PLANTING.				
Scutellum rot	51.19	0.77	50.12	16.10
Disease-free	68.25	4.65	67.06	11.24
Diplodia	31.74	7.50	32.14	25.92
Disease-free	64.28	6.17	69.40	12.00
Fusarium	70.63	6.37	68.25	29.06
Disease-free	76.19	12.50	59.12	22.81

east and the west plots were counted. There was a wide variation in the degree of smut infection. Most of the infection took place on developing ears and tassels. Infection took place also at the upper part of the nodes above and below the ear. In general, infection was localized; it occurred only in certain patches and spread from plant to plant. Dense vegetation and presence of moisture appeared to favor infection. As will be noted from Table 12, smut infection increased from the first

to the third planting. There was less smut infection in the fourth planting. This was very probably due to a drier atmosphere. More infection occurred in the west plots, the plots fertilized with manure and rock phosphate only. The results of this observation suggest an interesting problem; namely, that of the relationship of smut infection to nutrition of the corn plant.

TABLE 12.—*Number and percentage of diseased and disease-free corn plants infected with smut.*

Condition of seed.	East plots.			West plots.		
	Plants observed.	Plants killed.	Plants attacked.	Plants observed.	Plants killed.	Plants attacked.
	Number.	*Number.*	*Per cent.*	*Number.*	*Number.*	*Per cent.*
FIRST PLANTING.						
Scutellum rot	212	3	5.18	193	3	5.18
Disease-free	236	2	7.62	199	0	4.54
Diplodia	148	2	12.16	177	0	3.93
Disease-free	230	2	5.65	240	2	6.58
Fusarium	235	2	6.80	237	3	7.17
Disease-free	240	0	4.50	242	0	7.85
SECOND PLANTING.						
Scutellum rot	222	1	18.51	221	2	24.43
Disease-free	243	3	14.40	241	0	16.59
Diplodia	103	0	8.25	124	1	12.50
Disease-free	218	0	8.25	223	2	14.80
Fusarium	236	4	7.20	229	0	24.45
Disease-free	238	2	8.82	240	5	18.75
THIRD PLANTING.						
Scutellum rot	204	3	21.56	205	3	20.97
Disease-free	224	6	13.92	212	1	23.58
Diplodia	104	1	10.57	117	3	24.78
Disease-free	208	2	12.98	204	4	21.56
Fusarium	205	6	10.73	209	9	34.92
Disease-free	194	3	17.01	181	9	31.49
FOURTH PLANTING.						
Scutellum rot	129	0	6.20	149	1	18.79
Disease-free	172	0	10.46	169	1	21.30
Diplodia	80	0	8.75	81	0	8.72
Disease-free	162	0	10.49	175	3	22.85
Fusarium	178	1	7.30	172	2	20.34
Disease-free	192	0	6.25	149	3	19.26

DISCUSSION OF RESULTS

THE DEGREE OF INFECTION; ITS RELATION TO THE LIFE OF THE PLANT

Not all of the kernels on a *Diplodia* ear are infected. The infection on an ear varies. In a few cases, the infection is so severe that all the kernels are killed. In laboratory experiment *e*, kernels 1 to 13 in one row, and kernels 1 to 14 in another row, of seeds from an ear infected with *Diplodia* failed to germinate. The kernels at the butt end germinated, and the seedlings developed as normally as did the seedlings from disease-free kernels. In laboratory experiment *f*, in which were used kernels from an ear badly infected with *Diplodia*, it was found that practically all the kernels were infected; only a few kernels at the butt appeared free of infection. Identical results were obtained in laboratory experiment *g*. In germination tests of hundreds of ears, made by the department of agronomy, in which I had an opportunity of handling the ears to be tested and of observing the final results of the tests, it was found that most of the *Diplodia*-infected kernels were at the tip end of the ears. Infection of an ear may come through a wound on the shank or on the stalks; but the results of the observation show that a large part of the infection takes place through the tip of the ear. Ears the husks of which are tightly closed at the tip are less subject to infection by *Diplodia*.

The infection of the kernel also varies in degree as does the infection of the ear. *Diplodia* composite kernels give a very low percentage of germination. This was found true both in the laboratory experiments and in the field plantings. In laboratory experiment *b* (second part) and in laboratory experiment *d*, for example, the *Diplodia* composite kernels failed to germinate. In laboratory experiments *a*, *b*, and *i*, the percentage of germination of the diseased kernels was especially low. In the field plantings, the percentage of stand of plants on the *Diplodia* plots in the east and in the west sections was much lower than that of the other diseased corn and of the disease-free corn (Table 11). Seedlings from *Diplodia*-infected kernels succumbed at various stages of growth. Some plantlets died at a very early stage after germination; others grew for a few days, attaining a height of a few millimeters, and then died. Observation of germinating kernels and developing seedlings in the seed germinator shows that *Diplodia* killed corn much faster than did *Fusarium*. The severity of the attack of *Di-*

plodia appears to depend on the degree of initial infection in the kernels, other conditions being equal. In the struggle between the plant and *Diplodia* the parasite, in general, overcomes the corn.

Seedlings from *Diplodia*-infected kernels are very variable in height. In laboratory experiments *a* and *b*, and in other experiments not reported here, especially those in which rag dolls were used as germinating media, it was invariably found upon opening the rag dolls at the end of the experiment that the seedlings from the disease-free kernels were more uniform in height than were the seedlings from the diseased kernels. In the field plantings, the height of the plants, especially those from the *Diplodia* composite kernels, also showed greater variability. There was not much difference in the total heights reached by the plants on the diseased and on the disease-free plots. It will, however, be noted that the mean and the standard deviation of the heights of the plants on the diseased plots, particularly those on the *Diplodia* plots, show much higher probable errors. The coëfficient of variability of the heights of the plants on the diseased plots was consequently higher than that on the disease-free plots, in general. In the laboratory experiments, the degree of initial infection in the seed is very probably the cause of the greater variability in height of the seedlings. In the field plantings, the general results show that it may also be the cause of the greater variability in the heights of the plants on the diseased plots.

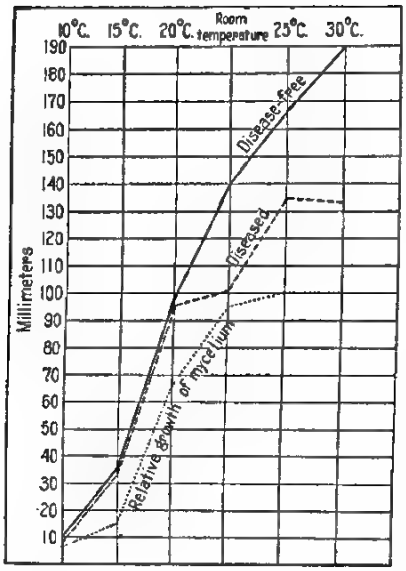


FIG. 1. Effect of temperature on growth of corn and *Diplodia*.

Seedlings from *Diplodia* composite kernels die at a very early stage. The seedlings that are able to pass through this early stage develop normally, in general. In the field experiments, in all four plantings there was no change in the stand of the plants on the *Diplodia* plots after the twentieth day from the

planting time. Only one or two plants on each *Diplodia* plot were noted, when the ears were developing, that were apparently infected with root rot; the other plants on these plots at maturity looked to be as normal as were those on the disease-free plots.

TEMPERATURE RELATIONSHIPS TO CROP AND DISEASE

That high temperature accelerates and low temperature inhibits germination and growth is very well known. In Plate 1 are shown the germination and growth of diseased and disease-free corn in different uniform temperatures for a period of one week. On the left side of each rag doll are the diseased kernels, and on the right side the disease-free; both kinds of corn are similarly subject to the effect of temperature. In laboratory experiment *a* the average growth of the disease-free seedlings for one week was raised from 9.8 millimeters at 10° C. to 189.5 millimeters at 30° C., and that of the diseased seedlings from 8.2 millimeters to 133 millimeters (fig. 1). In Table 3 the growth of the disease-free seedlings in sand containing 20, 40, and 60 per cent moisture is shown to have increased from 42 to 227 millimeters, from 72 to 228 millimeters, and from 100 to 294 millimeters, at 15 and 30° C., respectively. The effect of fluctuating temperatures on growth was shown in laboratory experiment *b*. In the first part of this experiment greater growth was shown in the uniform temperatures than in the fluctuating temperatures of the same mean (fig. 2). In the field plantings (fig. 3) it will be noted that, at the beginning of the curves for the growth increments of each planting, the seedlings in the later plantings showed a much higher average height in the first twenty days (the *Diplodia* plants having had a much slower start and then gradually overtaking the disease-free) and the curves of the growth increments of the diseased and of the disease-free plants generally

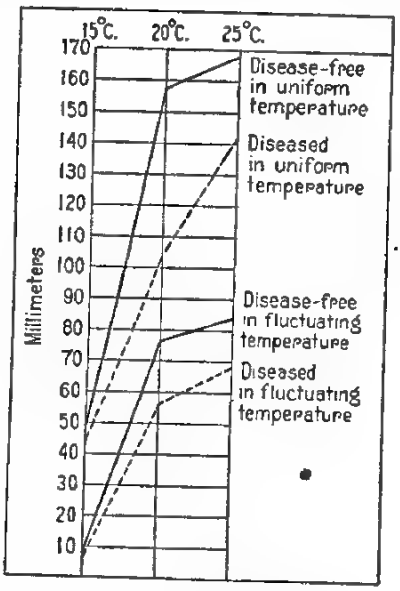


FIG. 2. Effect of fluctuating temperature on growth of diseased and disease-free corn.

zigzagged together, subject to the fluctuation of the weather elements. The growth increments of the plants on the *Fusarium* and on the scutellum-rot plots behaved similarly.

In figs. 6, 10, and 11, showing the relationship of the mean, the maximum, and the minimum temperatures to growth increments, the movements of the temperature and growth increments seem to indicate that the maximum temperature has a greater controlling influence on growth than has the minimum temperature. Figures 6 to 9 show that the greatest growth increments of the tassels occurred in the later plantings—more than 8 inches for the first planting, more than 10 inches for the second, more than 11 inches for the third, and about 11 inches for the last planting, showing greater rate of growth as the planting was delayed.

The severity of the attack of *Diplodia* increased with the rise in temperature. In laboratory experiment *a*, the percentages of kernels and seedlings that rotted were 20, 20, 75, 100, 100, and 100 and the relative spread of the mycelium was 7.5, 15, 65, 95, 100, and 100 (fig. 1) at 10, 15, 20°, room temperature, 25, and 30° C., respectively. In experiment *f*, the percentage of kernels and seedlings that rotted also increased with rise in temperature. Similar results were obtained in experiment *b* (first part); in the second part of this experiment, the development of the mass of the *Diplodia* mycelium increased with rise in temperature. Experiment *d* showed identical results with the maximum development of the *Diplodia* mycelium at 25° C. in sand containing 40 per cent moisture. In the field plantings, the severity of the attack of *Diplodia* is very clearly shown in the stand of the plants on the *Diplodia* plots. The percentage of stand decreased from 58.73 in the first planting to 31.74 in the last planting in the east plots, and from 70.23 in the early planting to 32.14 in the late planting in the west plots. The yields in the east and in the west plots decreased in about the same proportion as did the stand. It appears from the figures in Tables 6, 7, and 11 that the decrease in yield is due more to the decrease in stand as planting was delayed than to the reduction in size of the individual ears due to lateness of planting, at least so far as the four plantings in this experiment are concerned. *Diplodia* attacks corn at all the temperatures (10 to 30° C. in the laboratory experiments) used in these experiments. At 10° C., whereas the corn kernels at the end of one week had hardly germinated, the de-

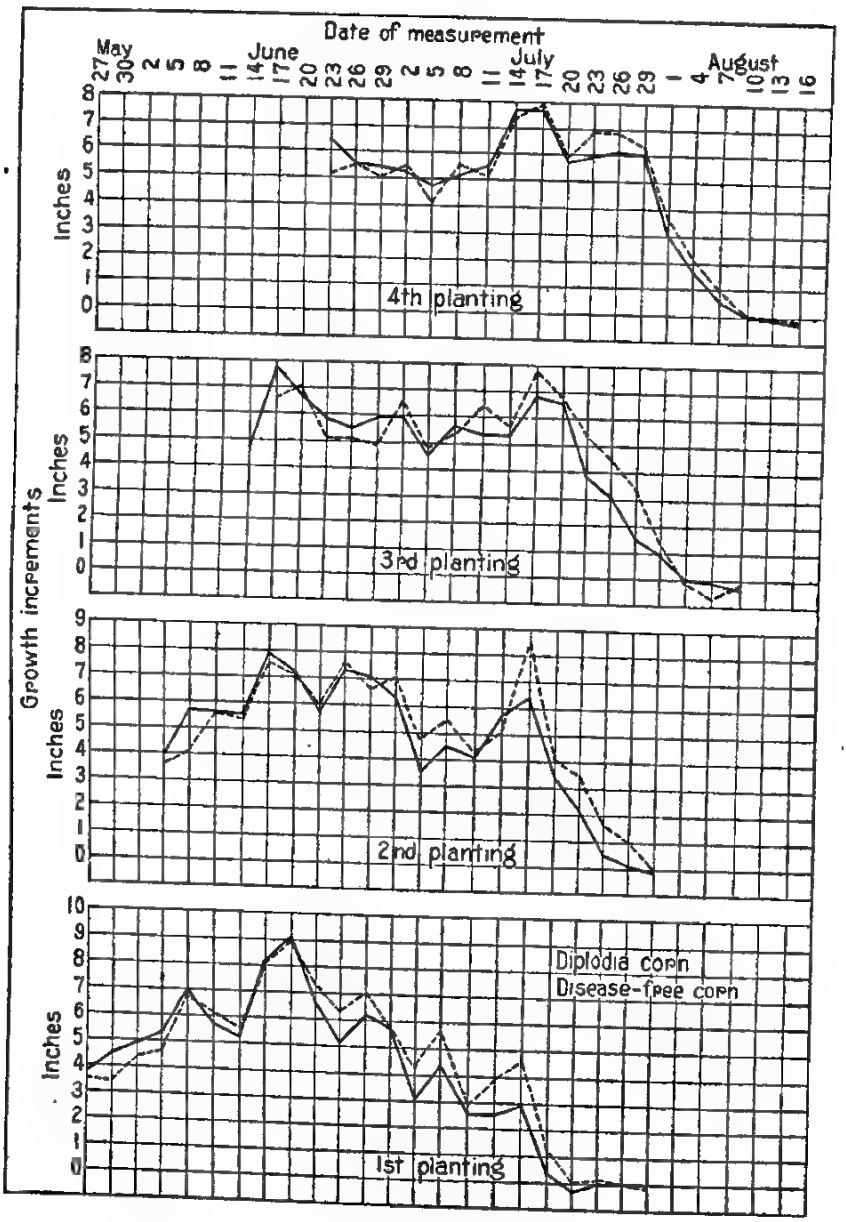


FIG. 8. Effect of the date of seeding on the growth of diseased (*Diplodia*) and disease-free corn.

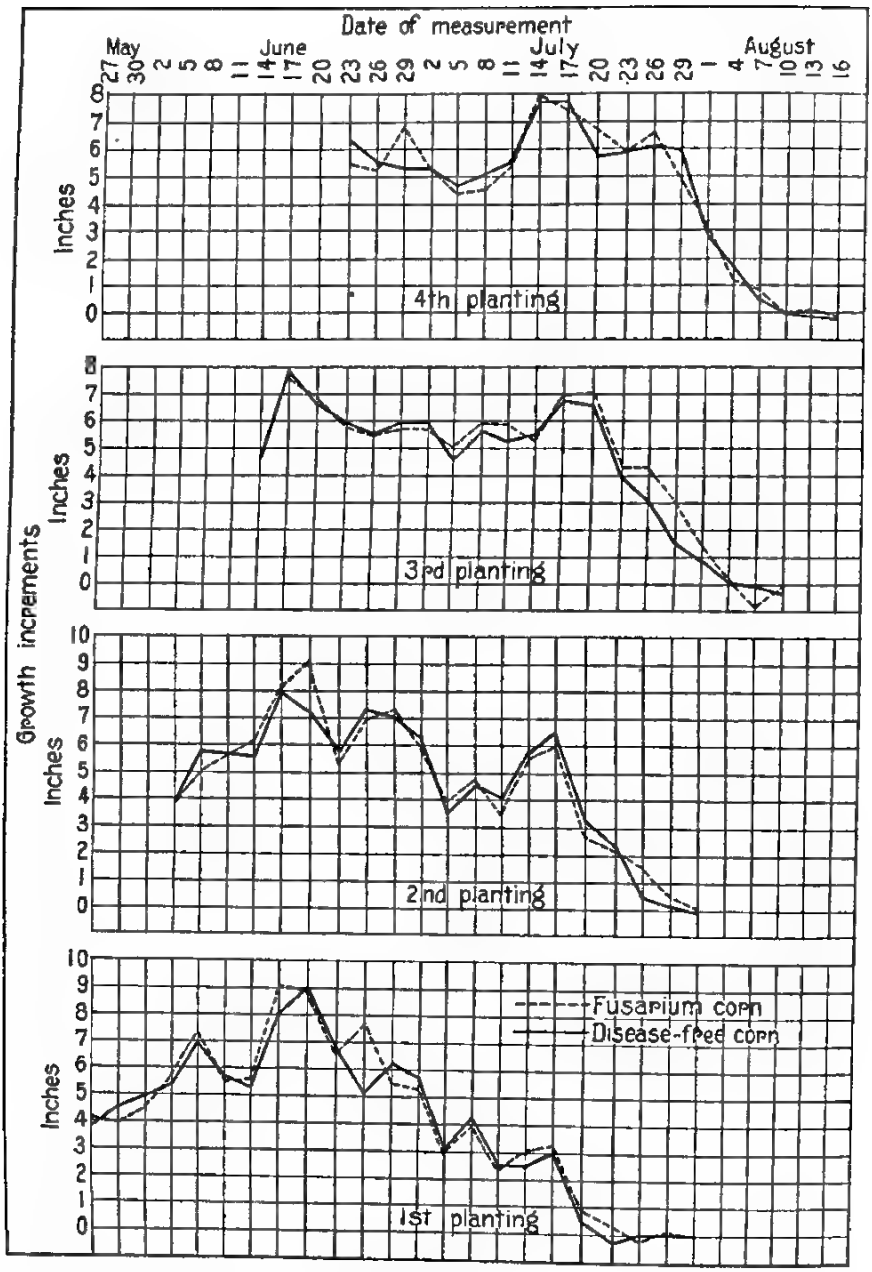


FIG. 4. Effect of the date of seeding on the growth of diseased (*Fusarium*) and disease-free corn.

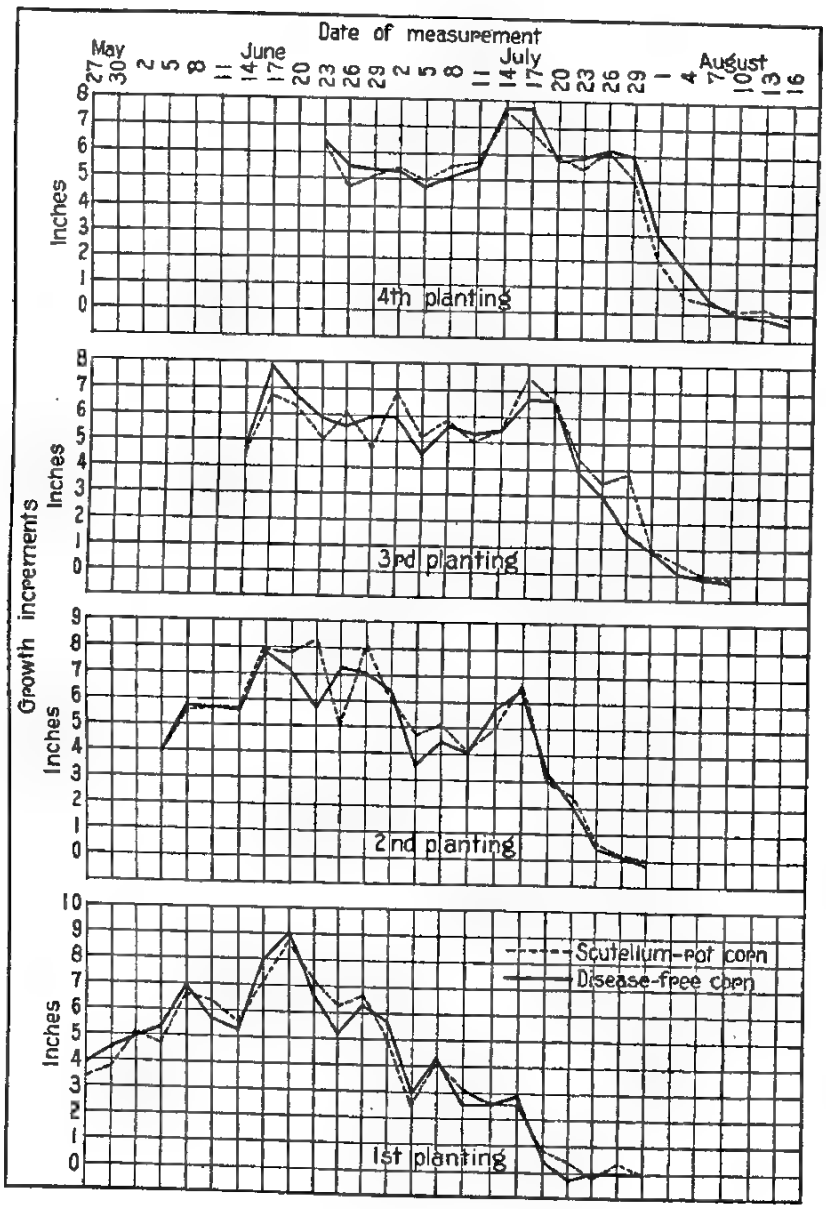


FIG. 5. Effect of the date of seeding on the growth of diseased (scutellum-rot) and disease-free corn.

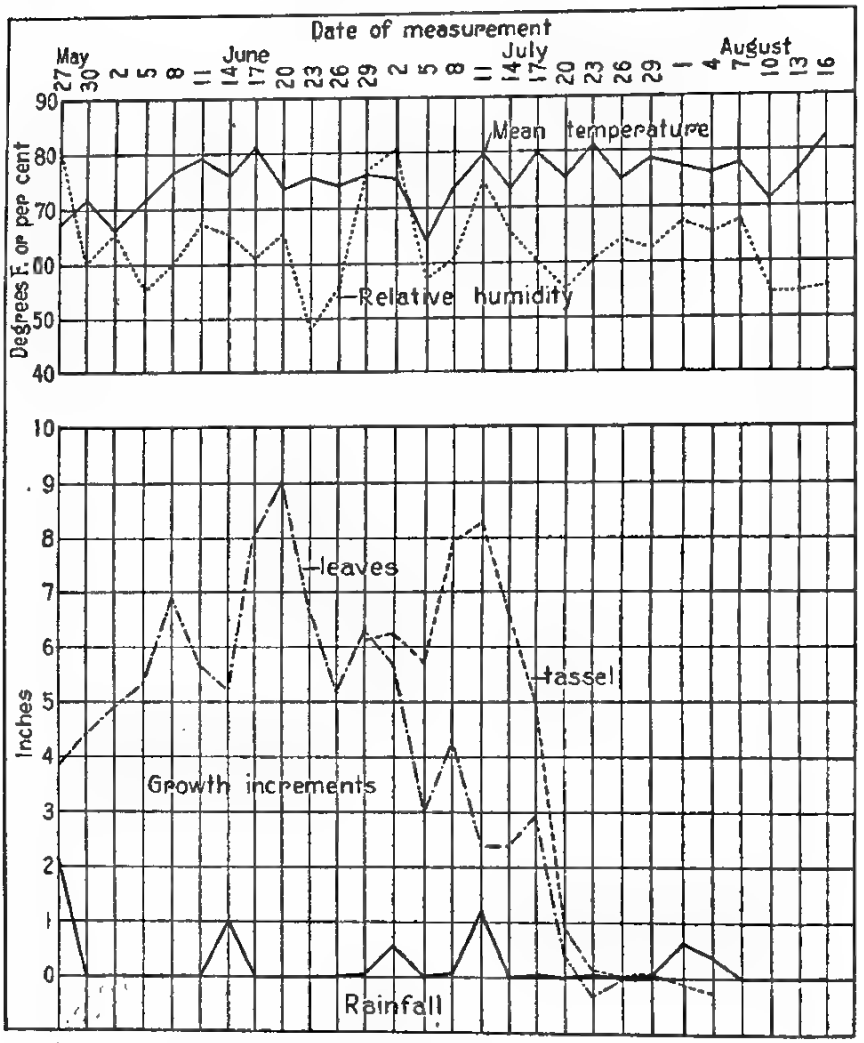


FIG. 6. Effect of mean temperature, relative humidity, and rainfall on the growth of disease-free corn. (First planting.)

velopment of the *Diplodia* mycelium was clearly evident. At the end of four weeks the average height reached by the seedlings that were infected was only about 12 millimeters, but the *Diplodia* mycelium had developed to the extent that whole seeds were thickly covered. Burril and Barret(9) state that the development of *Diplodia* is not confined to the summer months. They found mycelium in a growing active condition on ears partially covered with snow and ice. Parallel results were ob-

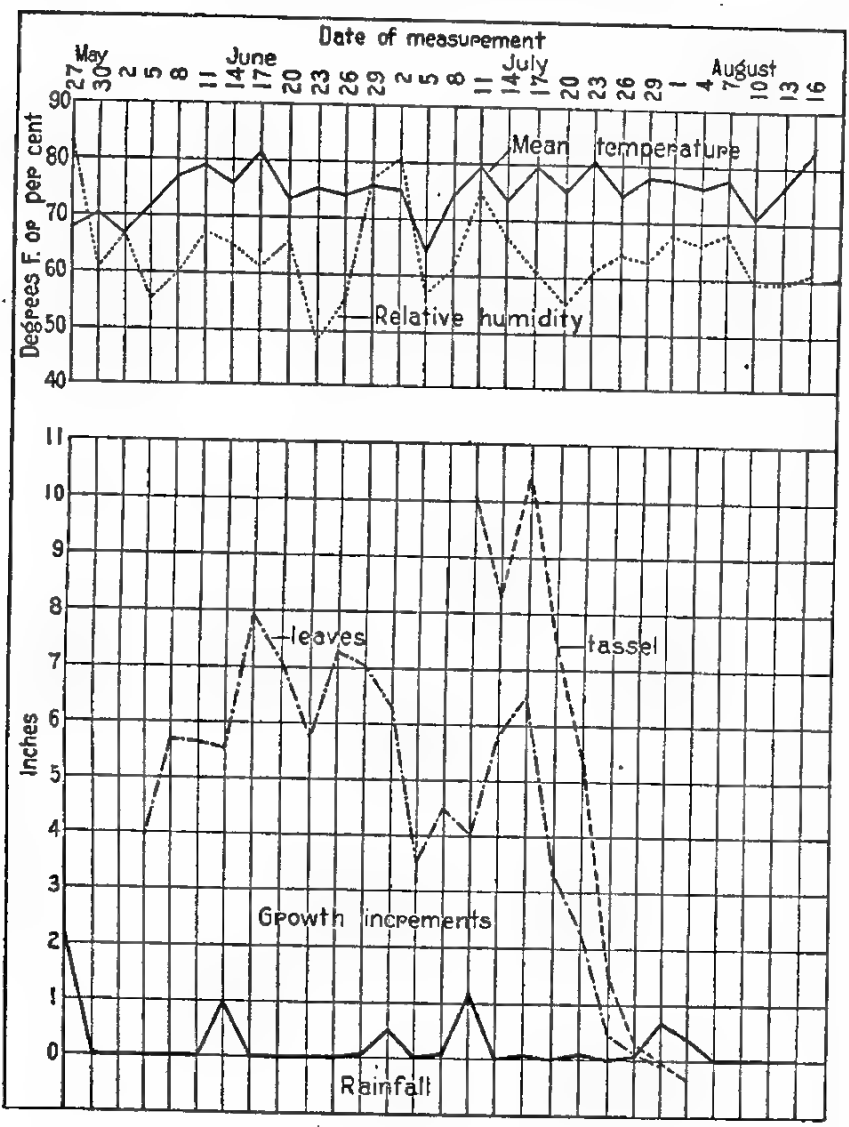


FIG. 7. Effect of mean temperature, relative humidity, and rainfall on the growth of disease-free corn. (Second planting.)

tained in the other temperatures. The cardinal temperatures for the development of *Diplodia* mycelium are apparently the same as the cardinal temperatures for the development of corn, the severity of infection depending largely on the degree of initial infection in the seed. It appears from observation that *Diplodia* develops under a wider range of temperature than does corn.

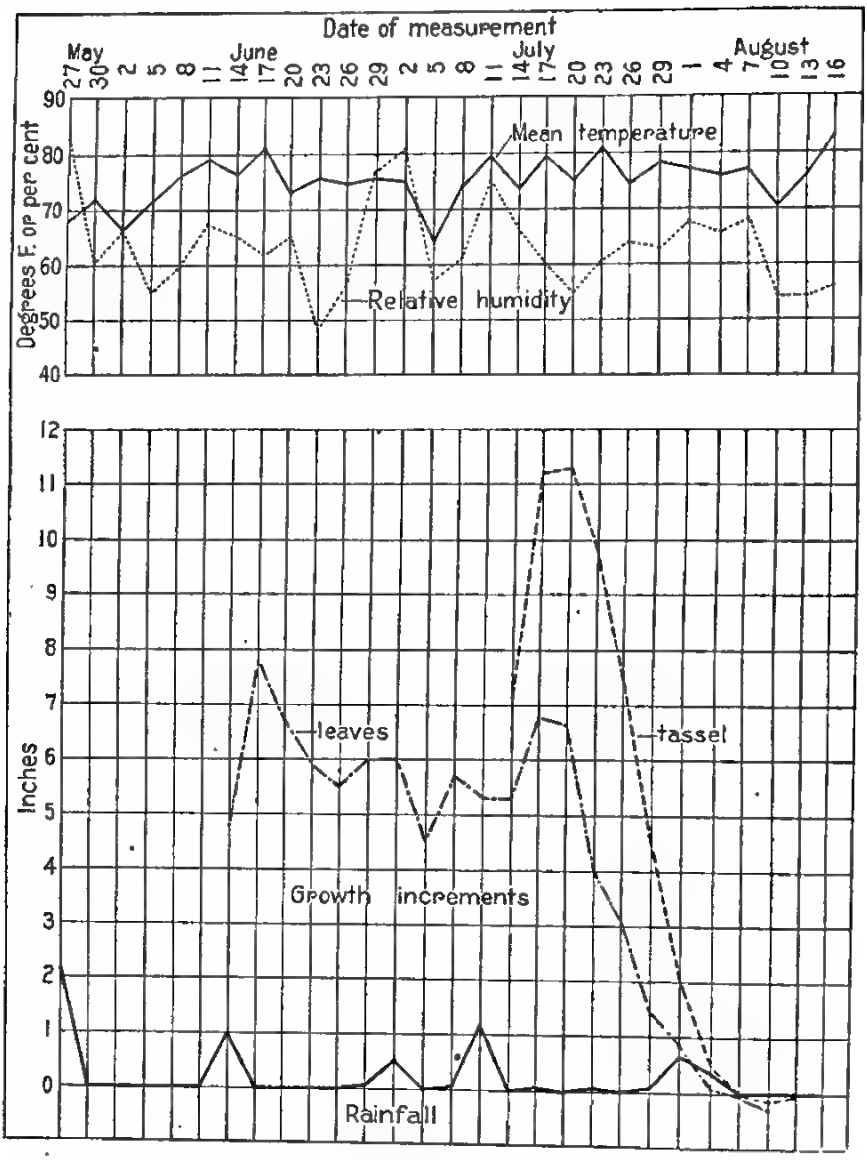


FIG. 8. Effect of mean temperature, relative humidity, and rainfall on the growth of disease-free corn. (Third planting.)

When *Diplodia* infection has started the death of the plant is hastened by other causes, among which are bacteria.

A perusal of the results obtained from the laboratory experiments and from the field plantings shows that the susceptibility of corn to *Diplodia* is increased with rise in temperature. The

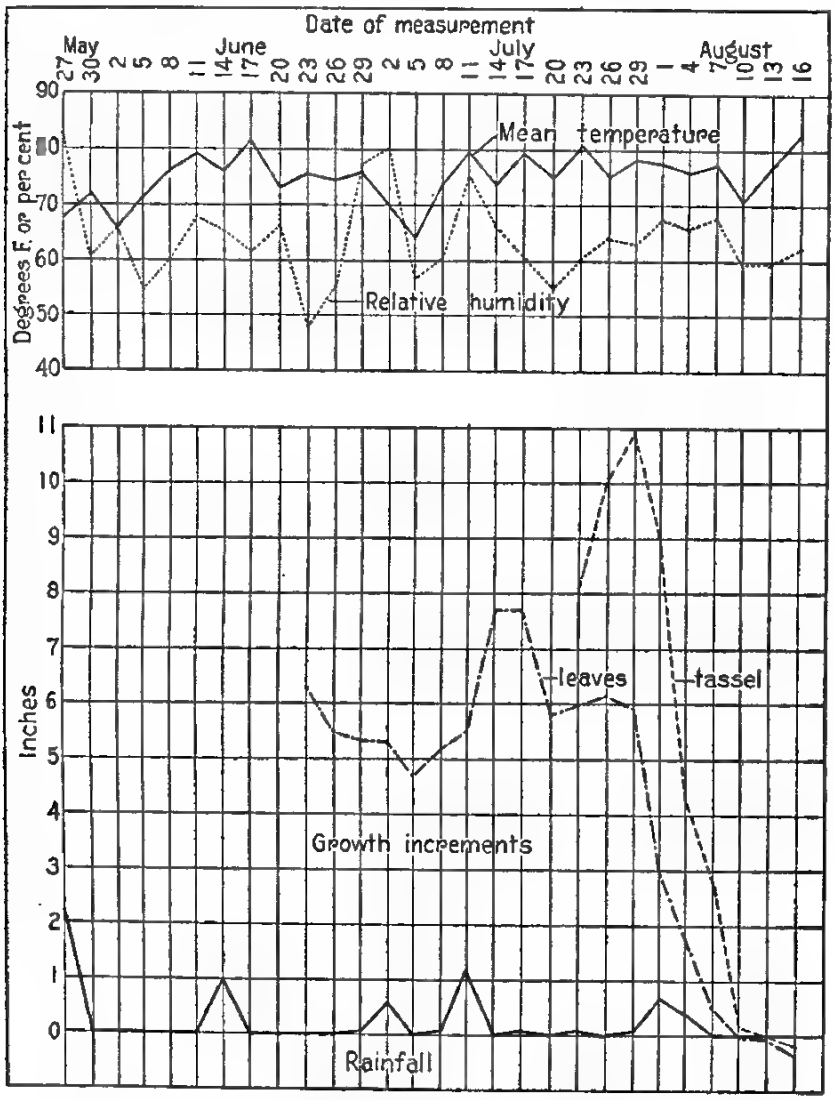


FIG. 9. Effect of mean temperature, relative humidity, and rainfall on the growth of disease-free corn. (Fourth planting.)

susceptibility of corn to smut also increases with rise in temperature. It will be noted from Table 12 that the number of plants attacked by smut and the severity of the attack, as judged by the number of plants killed, increased as planting was delayed. Reduction in the number of plants infected with smut occurred in the latest planting, the fourth; the plants in this planting were subjected to a considerably drier atmosphere than

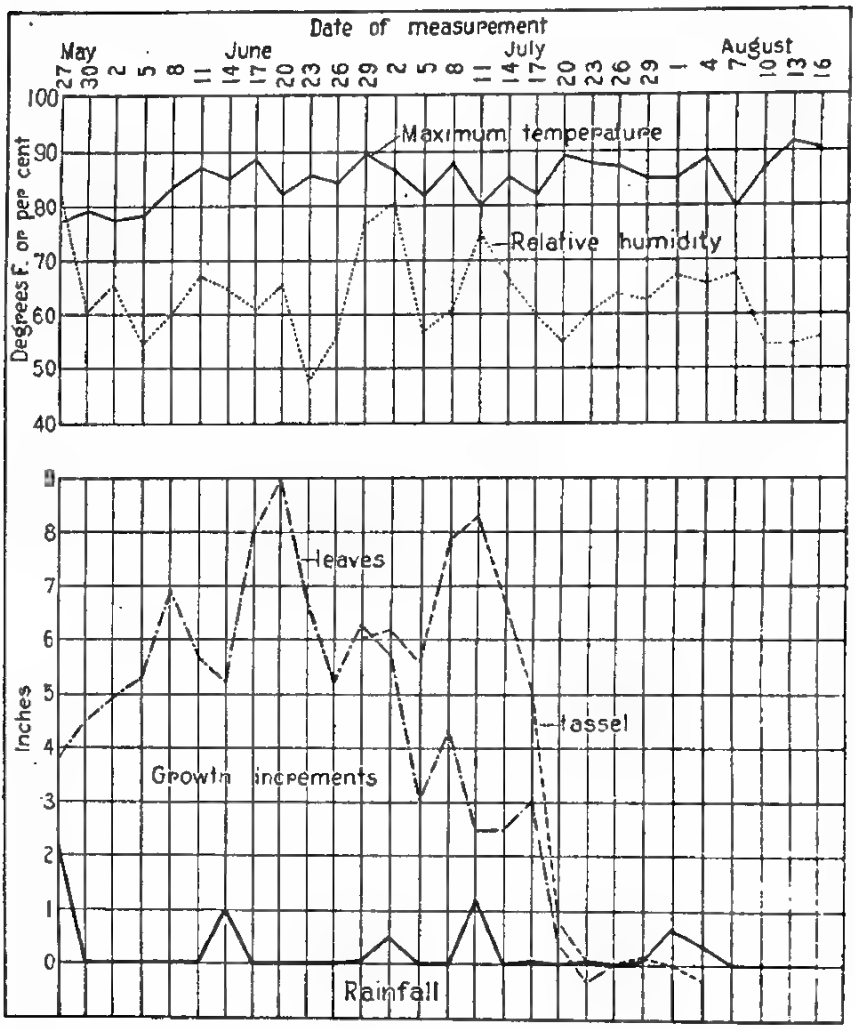


FIG. 10. Effect of maximum temperature, relative humidity, and rainfall on the growth of disease-free corn.

were those in the former plantings. The stand of the plants in this planting was also thinner, thus probably limiting the spread of smut from plant to plant. The work of Brooks and Cooley(7) on the bitter rot in apples, that of Gilman(10) on the relation of temperature to cabbage yellows, that of Jones and Tisdale(15) on the influence of temperature on the development of flax wilt, and that of other investigators(25, 28, 35) on the relation of temperature or climate to infection, have shown that the host plants are more susceptible to parasites at higher

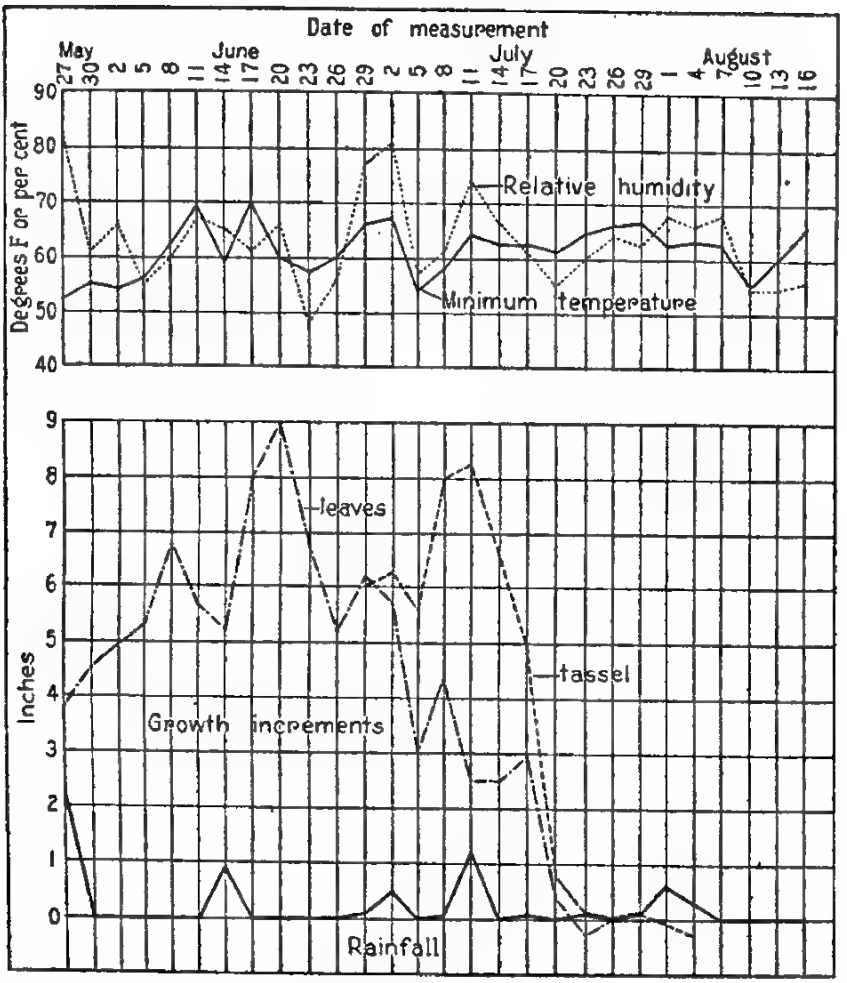


FIG. 11. Effect of minimum temperature, relative humidity, and rainfall on the growth of disease-free corn.

temperatures. Jones and others(16) have found, further, that even relatively resistant cabbage becomes susceptible when grown at high temperatures. It appears that parasites are most pathogenic at the temperature of their most active development. However, in the consideration of the relationship of temperature to disease resistance and susceptibility, not only the presence of the organism must be known, to begin with, but also the stage in the life cycle of the organism and the mass of the organism present.

MOISTURE RELATIONSHIP TO CROP AND DISEASE

The rôle that moisture plays in growth is as indispensable as the rôle played by temperature. The former is more important than the latter at one time, and the latter more important than the former at another time. In Tables 1, 3, and 5, the effect of moisture on growth is very clearly shown. Table 5 shows that at 30° C. the total heights reached by the seedlings in sand containing 20, 40, and 60 per cent moisture for one week were 250, 282, and 320 millimeters, respectively; Table 3 shows that at 10° C. the growth of the seedlings for one month was 32, 49, and 58 millimeters in sand containing 20, 40, and 60 per cent moisture, respectively. From Table 5, the rôle of moisture in increasing the growth of disease-free seedlings is also very evident. In experiment *c*, retardation in the rapidity of germination took place in the pan containing the highest moisture content. It was found in other experiments that, in cultures containing a high percentage of water, the germination of the kernels, especially at the lower temperatures, was retarded. In experiment *g*, in which kernels from different rows of an ear infected with *Diplodia* were used, it was found that the percentage of germination in wet soil was much lower than that in moist soil. Within certain limits, the growth of the *Diplodia* mycelium was increased by an increase in moisture in the media. The increase in development of the *Diplodia* mycelium, caused by an increase in moisture, was also found in experiment *d*, except in the sand containing 60 per cent moisture, in which case the lack of development of *Diplodia* was probably due to the degree of initial infection in the seed, or to organisms repressing the growth of *Diplodia*. In figs. 3 to 5 it will be noted that the growth increments of the three kinds of diseased plants (*Diplodia, Fusarium,* and scutellum rot) and the growth increments of the disease-free plants are affected by fluctuation of the weather elements in the same way. Because of the supposed infection in the roots, the plants on the diseased plots were expected to cease growth earlier, and to show low growth increments after rainless days. They were also expected to show more drying up of the lower leaves. These expectations were not realized. The growth increments of the plants on the diseased and on the disease-free plots followed each other so closely (growth stopping at about the same time) that these indices of root destruction were of no value. In figs. 6 to 11 it will be noted upon examination of the various curves

that the effect of moisture and temperature on growth under field conditions is not easy to determine. However, it is easily seen from these curves that the effect of rainfall is not immediate, while that of temperature of the air and relative humidity is immediate. The effect of rain is not expressed in growth, at least not until after the third day. In fig. 6 it will be noted that the growth response of the disease-free plants to the rains on May 27, June 14, and July 2 and 11 was not evident until some days later. In the early planting (fig. 6) it appears that the late growth response is due to the lowering of the temperature of the air, caused by the rain; but in the last planting (fig. 9) the late growth response cannot be due to the lowering of the temperature due to the rain, as the relative positions of the growth-increment point and the temperature point on July 11 show. The relation between the growth of the plant and the weather elements is a complex one. The curve of growth in fig. 6 can be considered as an example. Starting on May 27, the three-day sum of growth to May 30 was positively associated with the temperature, and negatively associated with the relative humidity; to June 2, the growth was negatively correlated with the temperature, and positively correlated with the relative humidity; to June 5, the growth was again positively associated with the temperature, and negatively associated with the relative humidity; and to June 8, the growth was positively correlated with both the temperature and the relative humidity. On June 11, however, the growth due to shortage of soil moisture on account of lack of rain for several days could not follow either the relative humidity of the air or the temperature. Following the courses of the curves in figs. 7 to 9 it will be noticed that, as long as the moisture of the soil is sufficient, the relative humidity has a powerful influence on growth. On the other hand, when the soil moisture is insufficient, the relative humidity does not affect growth. In his experiment on the effect of relative humidity and temperature on the growth of bean seedlings, Patterson(26) found in the laboratory, under controlled conditions, the same relationship between soil moisture, relative humidity, and growth. In the second, third, and fourth plantings, the curves in the corresponding figures for these plantings show the same relationship between weather elements, soil moisture, and growth. At one time growth goes with the temperature of the air; at another time with the relative humidity; and at still another time with

the soil moisture. The work of Shibata,(32) Lock,(22) and Smith(33) is very well known, and the reconciliation of the results obtained by these investigators proposed by Blackman(5) in his theory of limiting factors appears to hold in substance, as far as the results of these experiments are concerned. The principle also appears to hold true in the relationship of temperature and moisture to the development of plant diseases.

The particular stage in the life cycle of the corn plant must also be taken into consideration in the study of the relationship of temperature and moisture to growth increments. The growth increment, as will be noted in figs. 6 to 9, rises progressively until it reaches its maximum, and then decreases gradually. It seems that, if the plant were subjected to absolutely uniform conditions, the curve of the growth increments would ascend and descend gradually, showing that the amount of growth-increment response to the same condition varies according to the particular stage in the life cycle of the plant. In fig. 6, for example, on June 5, after nine rainless days, when the relative humidity and the temperature of the air were not higher than on previous days, the growth increments are shown to have risen gradually because of other factors. It is clear that the correlation table cannot reliably interpret the relation of temperature or moisture to growth of corn.

SUMMARY

Infection of corn by *Diplodia zeae* (Schw.) Lev. is generally effected through the tip of the ear.

The degree of infection of the ear and of the kernel varies.

The length of life of the seedling or of the plant depends upon the degree of initial infection in the kernel.

The severity of the attack on corn by *Diplodia* increases with rise in temperature.

Corn is more susceptible to *Diplodia* and to smut at higher temperatures.

The cardinal temperatures for the development of *Diplodia* parallel the cardinal temperatures for the development of corn.

Diplodia has a wider range of temperature for its development than has corn.

The decrease in yield as seeding was delayed, as far as the experiments reported here are concerned, is due more to the reduction in stand than to the reduction in size of the ear due to lateness of planting.

Plants on the diseased plots were more variable in height than were plants on the disease-free plots.

The death of corn caused by *Diplodia* generally takes place in the plantlet stage.

Plants that escape the *Diplodia* attack in the early stage develop just as normally as do disease-free plants.

Leaning and fallen plants, production of suckers, and production of brace roots are not conclusive evidences of root destruction caused by root-rot organisms.

The relationship of temperature and moisture to the growth of diseased and disease-free corn follows the law of limiting factors.

ACKNOWLEDGMENTS

This work has been carried on under the joint advice of Dr. William L. Burlison, professor of crop production, and Dr. Charles F. Hottes, professor of plant physiology, both of the University of Illinois. To them I am indebted for guidance and encouragement. I am also indebted to Dr. James R. Holbert, of the United States Department of Agriculture, for furnishing me with the seeds used in the laboratory experiments, and to Mr. George H. Dungan and his colleagues, in the division of crop production, for much valuable help in and information on the field experiments.

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ILLUSTRATIONS

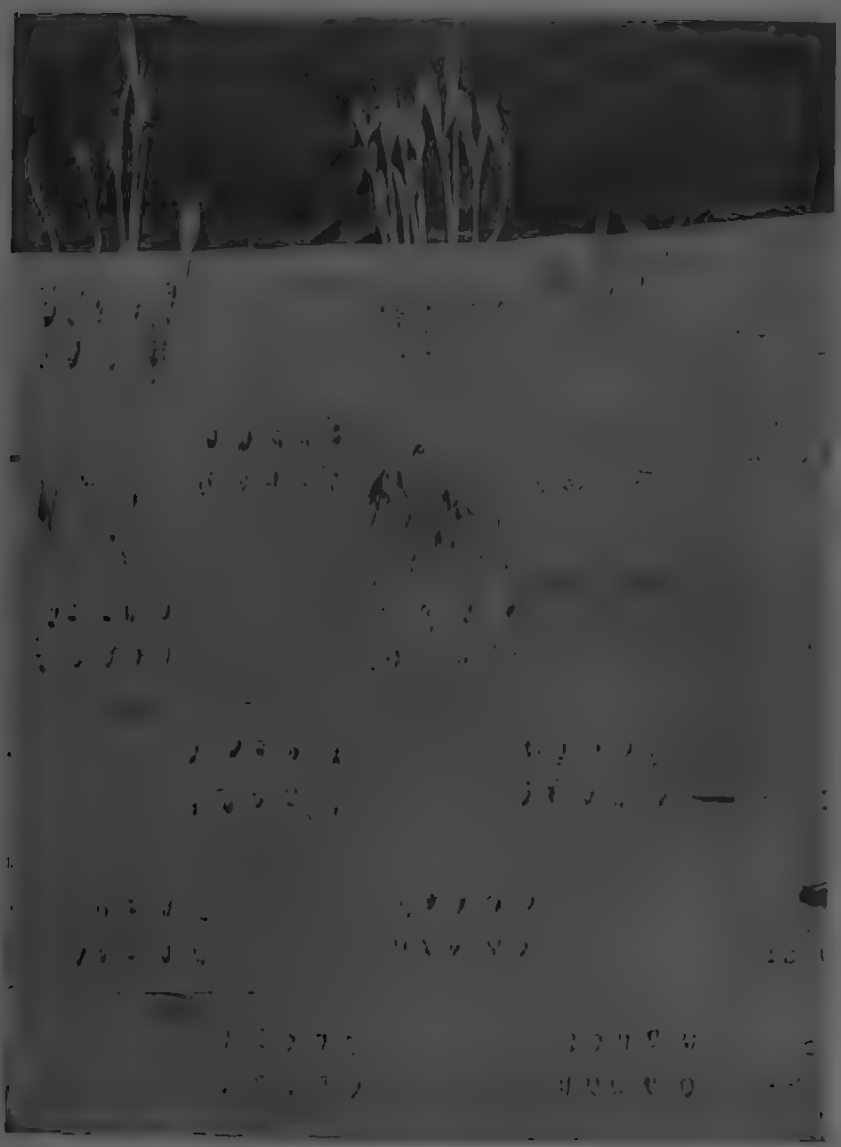

PLATE 1. EFFECT OF TEMPERATURE ON THE GERMINATION AND GROWTH OF CORN.

FOUR RARE PHILIPPINE FISHES

By ALBERT W. HERRE

Chief, Division of Fisheries, Bureau of Science, Manila

ONE PLATE AND ONE TEXT FIGURE

GEMPYLIDÆ

THE ESCOLARS

A group of mackerel-like fishes with elongate and more or less compressed body, covered with minute to very minute scales; the large head is laterally compressed, with projecting lower jaw and large mouth, the teeth very strong, some of the front teeth caninelike; the opercles are unarmed in adults, with radiating spines in the young; the dorsal fin is long, with a notch separating the weak spines from the rays; the anal and soft dorsal each with a prominent lobe anteriorly, and often with finlets posteriorly; the caudal peduncle is slender, usually not keeled, the caudal fin forked; the ventrals are small, often reduced to a single spine; the gill openings are wide, the membranes not united, free from the isthmus, gills four, a slit behind the fourth; vertebræ numerous, 32 to 53; pyloric cæca not numerous; an air bladder usually present.

Widely distributed fishes of the open sea, some of them descending to or living at considerable depths, most of them used for food.

But one genus is definitely known from the Philippines.

Genus PROMETHICHTHYS Gill

Promethichthys GILL, Mem. Nat. Ac. Sci. 6 (1893) 115, 123.

Body elongate, slender, spindle-shaped, laterally compressed; the spinous dorsal long, the soft dorsal and anal high anteriorly, each with two finlets posteriorly; the ventrals reduced to a pair of minute spines; no dagger-shaped spine behind vent; the mouth large with large canines anteriorly; the smooth scales very minute, the skin apparently naked; the lateral line undulating anteriorly, then it descends obliquely below the midline of the body and continues on back to the caudal fin.

Greedy fishes of the open sea, or bottom dwellers in moderately deep seas.

Promethichthys prometheus (Cuvier and Valenciennes).

Gempylus prometheus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 8 (1831) 156, pl. 222.

Gempylus solandri CUVIER and VALENCIENNES, Hist. Nat. Poiss. 8 (1831) 158.

Prometheus atlanticus LOWE, Proc. Zool. Soc. London 7 (1839) 78.

Thyrsites prometheus GÜNTHER, Cat. Fishes 2 (1860) 351.

Promethichthys prometheus GILL, Mem. Nat. Ac. Sci. 6 (1893) 115; GOODE and BEAN, Oceanic Ichthyology (1895) 200, with text figure; JORDAN and EVERMANN, Fishes of Hawaii, Part 1 (1905) 178, pl. 29.

Name at Cabalian, Leyte, *langpoi*.

Dorsal XVIII–1–18–II; anal II–17–II; V. I.

The low, elongate, slender body much compressed laterally, its extreme breadth 2.6 times in the depth, the extreme width of the head 1.73 times in the body depth and 3.6 times in the length of the head; the depth 6.4 times, the large, laterally flattened head a little more than 3 times in the length; snout long, sharp-pointed, 2.7 times in the head; the large circular eye high up, 4.15 times in the head, more than 1.5 times in the snout; the interorbital has an elongate concave groove, its breadth 1.44 times in the eye; mouth large, the lower jaw strongly projecting, the posterior angle of the maxillary beneath the front margin of the pupil; each jaw has a single row of strong, sharp, backward-inclined teeth, the first pair in the lower jaw longer and caniniform; at the front of the upper jaw in my specimen are three very large sharp fangs, one at the symphysis and a pair behind it, over half an eye diameter in length, very strong, fixed, and preventing the mouth from being closed; a row of small sharp backward-inclined teeth on each palatine; I find no teeth on vomer or tongue, as stated by Jordan and Evermann; the caudal is rather small, the upper lobe largest, a trifle less than 5 times in the length; the middle spines of the dorsal are longest, 1.3 times in the depth; the anterior dorsal and anal rays are highest, three-fourths the longest dorsal spine; the ventral is reduced to a single wide blunt spine; the whole body is covered with closely fitting smooth scales, largest posteriorly, those on the cheeks very minute; the lateral line runs nearly horizontally to under the fourth dorsal spine, then descends sharply, obliquely backward to the middle of the body, then describes a long, gradually downward curve, rising again on the lower half of the caudal peduncle, and continuing on the caudal fin; the pectorals are placed low down.

The color is purplish brown, with a silver sheen over all, the head blackish, the fin membranes all black.

Here described from a specimen 167 millimeters in length, caught with hook and line at a depth of about 50 meters, in the sea off Cabalian, Leyte. It is well known to the fishermen there. First known from St. Helena, in the south Atlantic Ocean, it has since been taken at Madeira, the Bermudas, Australia, Hawaii, and Japan. It is common at Madeira, where the fishermen capture it on the bottom at a depth of 100 to 400 fathoms.

MALACANTHIDÆ

The body is elongate, spindle-shaped, more or less laterally compressed; the labroid head somewhat conical, with thick lips and elongate snout, its profile more or less convex; no bony stay for the suborbital; the cranial bones not cavernous; the terminal mouth low, nearly horizontal; the teeth sharp, rather small, none on the vomer, palatines, or tongue; the premaxillary usually has a small blunt posterior canine, somewhat as in the Labridæ; the premaxillaries are protractile; maxillary not slipping under the edge of the preorbital, without a supplemental bone; lower pharyngeals separate; scales very small, ctenoid; lateral line complete, usually following the dorsal outline; the dorsal fin long, low, continuous, the spinous portion much shorter than the other part, but never wanting; the anal fin long, low, with one or two feeble spines or none; ventrals thoracic or subjugular, close together, with one spine and five rays; the caudal fin forked, the tail diphycercal; pectoral fins moderate, with only branched rays; gill opening wide, with four gills, a long slit behind the fourth; gill membranes separate or more or less united, often adherent to the isthmus; pseudobranchiæ well developed; branchiostegals five or six; air bladder simple; pyloric appendages few or none.

Fishes of the open sea or about oceanic islands, intertropical in range; some of them reach a large size and all are valued for food.

Genus **MALACANTHUS** Cuvier

Malacanthus Cuvier, Régne Animal, ed. 2, 2 (1829) 264.
Oceanops Jordan and Seale, Fishes of Samoa, Bull. Bur. Fisheries 25 (1906) 277.

The elongate body laterally compressed, the mouth horizontal or nearly so, jaws equal, the lips thick; dorsal very long, continuous, with four to six soft spines and 45 to 60 rays; anal with

one or two soft spines or none, and 40 to 55 rays; the operculum has a spine, the preoperculum is entire; the outer teeth are small with minute teeth behind, some of the teeth more or less enlarged.

The subgenus *Oceanops* Jordan and Seale, distinguished by its more-elongate snout and brilliant coloration, does not seem to me to be worthy of generic rank on such grounds.

Key to the Philippine species of Malacanthus.

1. Head and snout long, labroid; a broad black lateral band; dorsal 4–43 to 46; subgenus *Oceanops*..... **M. latovittatus.**
2. Head and snout shorter, convex; two black longitudinal converging bands on caudal fin; dorsal 5–53 to 57..... **M. parvipinnis.**

Malacanthus latovittatus (Lacépède).

Labrus latovittatus LACÉPÈDE, Hist. Nat. Poiss. 3 (1798) 527, pl. 28, fig. 2; QUOY and GAIMARD, Voy. Astrolabe 3 (1835) 701, pl. 20, fig. 3.

Malacanthus taeniatus CUVIER and VALENCIENNES, Hist. Nat. Poiss. 13 (1839) 239, pl. 381.

Malacanthus latovittatus GÜNTHER, Cat. Fishes 3 (1861) 360.

Oceanops latovittatus JORDAN and SEALE, Bull. Bur. Fisheries 25 (1906) 277.

Local name, *nalagalep.*

Dorsal IV, 43 to 46; anal I, 40; there are 130 scales in the lateral line in my specimen, 125 according to authors.

The elongate body subcylindrical from the head to the end of the short trunk, the tail laterally compressed and longer than the head and trunk together, the head elongate with produced snout, the anterior profile slightly convex from the first dorsal to the eyes, then straight to the tip of the snout; the depth 5.33 times, the head 3.63 times in the length; the head and trunk together contained 1.28 times in the tail; the mouth large, low down, nearly horizontal, the lips thick, the posterior angle of the maxillary falling much short of a perpendicular from the eye, its length 76.6 per cent of the snout; the teeth in the upper jaw in a broad band anteriorly, which is much narrowed posteriorly; the outer row is of enlarged teeth, terminating at the rear in a small canine, the other teeth minute; the teeth of the outer row in the lower jaw enlarged, sharp-pointed, those on the sides largest; behind this is a band of minute teeth, broad in front and disappearing posteriorly; the posterior margin of the opercle terminates in a strong sharp spine; the body everywhere covered with small, finely ctenoid scales, which

extend upon the nape and sides of the head beyond the eyes, those before the first dorsal minute; the dorsal low, the spines and rays all flexible, the rays a little forward of its middle longest, 3 times in the head; the anal equals the dorsal in height, the longest rays in its anterior portion; the caudal subtruncate, or the margin may be undulate-lunate, 1.83 times in the head, 6.66 times in the length; the pectoral equals the caudal, its central rays longest, ending in a long point; the ventrals narrow, very close together, 2.64 times in the head.

The color is brilliant violet blue above, with a broad deep black band from above and behind the pectoral to the caudal where it divides, part continuing to the caudal tip, and a broad band descending to the lower part of the fin, thence to the posterior extremity, leaving a white and golden square on the posterior part of the lower half of the caudal; the upper part of the caudal blue; the underside of the head and the belly pale whitish violet; the rest of the body below the lateral band and the anal yellowish white; the pectoral blackish basally, the rest of the fin greenish golden; the head blue with a curved black band behind and below the eye.

In alcohol the blue changes to blackish.

Here described from a specimen 240 millimeters long, caught with hook and line at Santo Domingo de Basco, Batan Island, Batanes Province, where it is well known to the fishermen.

This very beautiful fish was first described from Mauritius, in the Indian Ocean, and soon after from New Guinea, and for a long time was not known elsewhere. Its recorded range now includes Samoa, the Pelew Islands, and a number of East Indian localities recorded by Bleeker. The colors are subject to a considerable degree of minor variation, but the intense blue above, the long black lateral band, and the paler underparts are always present.

Malacanthus hoedtii Bleeker.

Malacanthus hoedtii BLEEKER, Act. Soc. Sc. Indo-Neerl. 6 (1859) 18; GÜNTHER, Cat. Fishes 3 (1861) 361; Fische der Südsee 2 (1876) 160, pl. 98, fig. B.

Malacanthus parvipinnis VAILLANT and SAUVAGE, Rev. Maj. Zool. 3 3 (1875) 283; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 [1] (1903) (1905) 276, fig. 118.

Local name, *tevay*.

Dorsal V, 53 to 57; anal I, 50 to 51 in my specimens ("A. 50", Günther; "A. 53", Jordan and Evermann); 168 to 173

scales in the lateral line to the end of the caudal vertebræ, with four or five more tubules extending on the caudal.

The head and body laterally compressed, spindle-shaped, the dorsal and ventral profiles tapering strongly back to the caudal peduncle, the depth 6.4 to 6.8 in the length; the anterior profile of the head strongly convex, 4.7 to 4.94 times in the length; the posterior margin of the opercle ends in a strong spine, not included in the length of the head given above; the long convex pointed snout 3 times in the head; the eye very high up, lateral, 3.9 times in the head; the broad, flat interorbital 2.83 to 3 times in the head; the mouth very low down, oblique to almost horizontal, the upper lip thick, the posterior angle of the maxillary beneath the front margin of the large pupil; the nostrils in front of the middle of the eye, the anterior one circular with a tubulate lip, the posterior one a horizontal slit; the outer teeth in the upper jaw enlarged, especially at the front, terminating near the angle of the mouth in a small, forward-pointed canine; about five rows of minute teeth in a band behind the outer row anteriorly, decreasing in number and disappearing at the middle of the jaw; in the lower jaw a short band of six or seven rows of teeth is behind the symphysis, all the teeth minute except those of the outer row; the outer teeth increase in size posteriorly, largest at the middle of each side, where there are three or four stout conical teeth; behind these the row is continued by much smaller teeth; the scales very small but distinct, extending forward to the eyes and well out on the caudal fin, those before the first dorsal minute, indistinct; the scales of the lateral line minute; the dorsal and anal very long, sharply angulate posteriorly, highest before the central part of their length, the most anterior portion very low, all the spines and rays flexible, the longest rays of the two fins equal in height, 2.6 to 2.7 in the head if measured along their length, 4.25 times in the head if the vertical height is measured; the caudal truncate, 7.6 to 8 times in the length, 1.6 times in the head; the depth of the caudal peduncle about 3.8 times in the head; the pointed pectoral 7 to 7.4 times in the length, 1.45 to 1.5 times in the head; the narrow pointed ventrals very close together, 10.66 to 11.1 times in the length, 2.2 to 2.26 times in the head.

The color of a fresh specimen was smoky gray above, with about twenty vertical curved or angulate bars of the same color

on the sides and descending nearly to the bottom, the lower parts fading into white; on the cheeks and opercles were a number of small lemon yellow spots, and the tip of the lower jaw was also lemon yellow; the dorsal was red, the anal lemon yellow; the caudal bright lemon yellow, with two longitudinal jet black bars, beginning on the caudal peduncle at the upper and lower origins of the caudal and converging but not meeting posteriorly; the pectoral was slightly smoky gray; the ventrals were white.

In alcohol the dorsal has lost its red hue, and the yellow has faded, except on the caudal; the colors are otherwise unchanged.

Here described from two specimens, 160 and 178 millimeters in length. They were caught with hook and line at Santo Domingo de Basco, Batan Island, Batanes Province, where this fish is common.

This Quaker-clad fish is found from Mauritius to Hawaii and the Society Islands.

XIPHASIIDÆ

This family of eel-like naked blennies has the tail greatly elongated, laterally compressed, the eyes very large, lateral, the dorsal and anal very long and united to the caudal; the ventral fins are of three rays, elongated and filamentous, inserted on the throat at the branchial arch, before the gill opening; the maxillary and mandibulary teeth are of uniform or nearly uniform size, close together; far back in the lower jaw is a pair of enormous curved canines; still farther back in the upper jaw is a pair of much smaller though still large canines; the palate is toothless, the suborbital bone is rough.

A group of strange-looking and rare fishes, with one genus and two or three distinct species—one of unknown habitat, the others hitherto only known from the Indian Ocean.

The function of the extraordinary canines, particularly the preposterous ones of the lower jaw, is not clear. It is difficult to believe that the fish could open its mouth sufficiently to use them in defending itself. They are so long and so curved that the points are out of sight even when the mouth is opened to its fullest extent. Of course it is possible that in life the jaws might open more widely. According to Jerdon, quoted by Day, it is "said to be venomous."

Genus XIPHASIA Swainson

Xiphasia SWAINSON, Nat. Hist. 2 (1839) 259.
Nemophis KAUP, Proc. Zool. Soc. London (1858) part 26, 168.
Xiphogadus GÜNTHER, Cat. Fishes 4 (1862) 374.

The tail is 4 to 5 or more times as long as the head and trunk together, much compressed laterally, especially posteriorly, the trunk and head more rounded but also laterally compressed, the whole body very low; the fin rays all flexible, the dorsal beginning on the head, before, behind, or above the eyes; the gill openings small, restricted, before the base of the pectoral fin; the dorsal and anal high; branchiostegals six. The other characters are as given for the family.

Xiphasia setifer Swainson.

Ophidium tonkah-talawaree RUSSELL, Descriptions and Figures of Fishes of Coromandel 1 (1803) 28, pl. 39.
Xiphqsia setifer SWAINSON, Nat. Hist. 2 (1839) 259; DAY, Fishes of India (1878) 337, pl. 73, fig. 1.
Xiphogadus setifer GÜNTHER, Cat. Fishes 4 (1862) 374.

Dorsal 126; anal 112.

The form is very elongate, slender, eel-like, laterally compressed, especially on the tail, the depth just back of the head 33.5 times in the length; the tail very attenuate, becoming ribbonlike posteriorly, and is 85 per cent of the length; the head is boldly convex anteriorly, nearly as long as the trunk, wider than the body, 14.37 times in the length, its depth a fourth greater than its breadth and two and a third times in its length; the trunk subcylindrical, a little less than 13 times in the length; the head and trunk together are 5.8 times in the length; the eye is rather large, circular, lateral, high up, 4.375 times in the head, 1.375 times in the snout, which is strongly convex, downward projecting, 3.18 times in the head; the mouth slants up and back, the lower jaw the shorter, with slender, somewhat irregular, flattened, incisorlike teeth closely appressed in a compact projecting row in each jaw; posteriorly to the row of teeth in the lower jaw is a pair of relatively enormous, very strong, sharp, backward-curved canines, their length three-fourths of an eye diameter; these canines fit into large cavities running upward and backward before the eyes; behind these cavities is a pair of much smaller, downward-projecting canines, only their tips showing when the mouth is fully stretched open.

The dorsal begins before the eye and gradually increases in height, reaching its maximum before the posterior end of the

first third of the body, then gradually decreasing to the tail, the longest ray about 1.85 times in the head, the greatest vertical height of the fin 2.9 times in the head; the anal is similar, its greatest height about the middle of its length 3.88 times in the head, the longest ray 3.18 in the head; the caudal has its two central rays greatly elongated, hairlike, 10 times in the length; the pectoral is rather broad, short, 1.94 times in the head; the ventrals are very narrow, elongate, 1.84 times in the head.

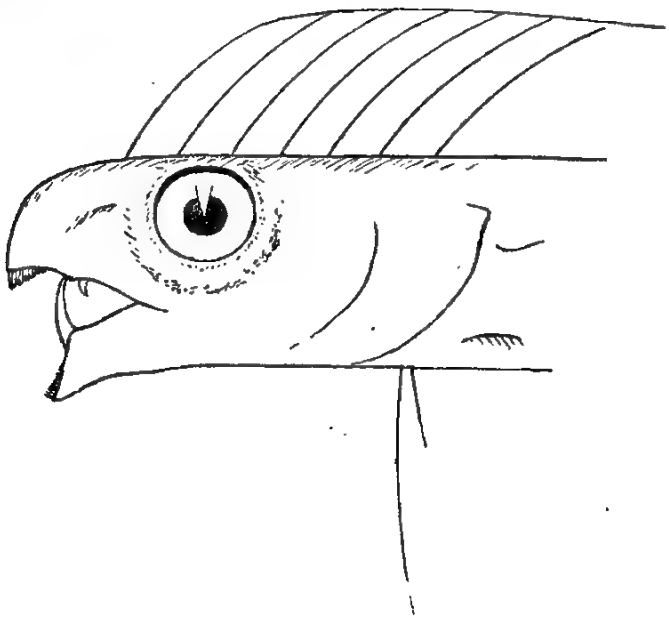

FIG. 1. *Xiphasia setifer* Swainson; head, × 2.

The color when fresh was bright yellow, with twenty-eight broad dusky brown crossbands on the dorsal and body, the first just behind the head; the dorsal yellow at its origin, both dorsal and anal with a broad marginal blackish band; the caudal filament black; the head dusky yellowish; the ventrals yellow; the pectorals yellow with flesh red longitudinal lines.

In alcohol the yellow has faded to pale brownish yellow and the dorsal is largely black, the pectoral dusky; the fading has caused the fish to appear as though crossed by eleven wide pale bands, each between a pair of blackish brown bars.

Here described from a specimen 503 millimeters long, collected at Dumaguete, Oriental Negros, by Dr. J. W. Chapman, professor of biology at Silliman Institute.

ILLUSTRATIONS

PLATE 2. XIPHASIA SETIFER SWAINSON, × ¾

NEW FLAGELLATA FROM NORTH MANCHURIA, CHINA [1]

By B. W. Skvortzow

Of Harbin, Manchuria

ONE PLATE

In a series of notes on Flagellata of Manchuria I have already described more than one hundred fifty new species and varieties of *Trachelomonas* Ehrenberg. Many of the new forms of these inferior organisms were of scientific interest due to their peculiar construction and geographic distribution.

The investigation of water basins, continued by me in the summer of 1924, has convinced me of the original character of the Flagellata observed.

In the present note I give a description of twenty-seven forms of this genus kindly gathered for me by Mr. I. W. Kozlov in August, 1924, in rice fields of the Mutatiang River in the eastern part of the country, near Eho station of the Chinese Eastern Railway. Sixteen of these are new and are here described.

Trachelomonas volvocina Ehrenberg.

Shell brown, 10 to 15 μ in breadth. Common.

Trachelomonas kelloggi Skvortzow **var. punctata** Skvortzow. Plate 1, fig. 11.

Shell brown, dotted, 40.8 μ in length, 30.8 μ in breadth. Flagella hole, 5 μ in breadth. Chromatophores numerous.

Trachelomonas kelloggi Skvortzow **var. coronata var. nov.** Plate 1, fig. 1.

Shell brown, oval, broad-elliptical, dotted. Flagella hole covered with spines. Shell, 25.5 μ in length; 20.4 μ in breadth. Flagella hole, 2.5 μ in breadth. Chromatophores numerous.

Trachelomonas depressa Swirenko **var. punctata** Skvortzow. Plate 1, fig. 2.

Shell brown, dotted, 18.7 μ in length, 21 to 22 μ in breadth. Flagella hole, 2.5 μ in breadth. Chromatophores numerous.

[1] From the Sungari River Biologic Station of the Manchuria Research Society, at Harbin.

Trachelomonas pulchra Swirenko var. **punctulosa** var. nov. Plate 1, fig. 3.

Shell brown, dotted, 24 μ in length, 22 μ in breadth. Flagella hole, 2 μ in breadth. Chromatophores numerous.

Trachelomonas wislouchi Skvortzow. Plate 1, figs. 4 and 5.

Shell brown, 25.5 μ in length, 28.9 to 30.6 μ in breadth. Flagella hole, 5 μ in breadth. The enlarged neck, 23.8 to 25.5 μ in breadth. Spines obtuse, 2 to 2.5 μ in length. Five or six obtuse spines are placed around the flagella hole, but at some distance from the hole.

Trachelomonas wislouchi var. **glabra** var. nov. Plate 1, fig. 6.

Flagella hole without obtuse spines, but with an angular brim. Shell spines small, in other respects similar to the typical form.

Trachelomonas wislouchi Skvortzow var. **collaris** var. nov. Plate 1, fig. 7.

Flagella hole with outside spines thickly placed around the hole, in other respects similar to the typical form.

Trachelomonas plantonica Swirenko var. **kozlovi**[2] var. nov. Plate 1, fig. 8.

Shell brown, dotted, 27.2 μ in length, 22 μ in breadth. Neck turned up, 4.2 μ in length, 3.4 μ in breadth. Chromatophores numerous.

Trachelomonas arnoldiana Skvortzow var. **manchurica** var. nov. Plate 1, fig. 12.

Shell brown, covered with knobs; 27.2 μ in length, 22.5 μ in breadth. Neck straight, 5.9 μ in length, 3.4 μ in breadth. Chromatophores numerous.

Trachelomonas raciborskii Woloszynska var. **punctata** Skvortzow. Plate 1, fig. 25.

Shell brown, 40.8 μ in length, 30.6 μ in breadth. Flagella hole, 3.4 μ in breadth.

Trachelomonas baikovi Skvortzow var. **punctata** var. nov. Plate 1, figs. 13 and 14.

Shell brown, dotted and covered with spines; 47.6 to 52.7 μ in length, 25.5 to 27.2 μ in breadth. End spine, 8 to 8.9 μ

[2] Named in honor of Mr. I. W. Kozlov, botanist, who found this form.

in length. Neck, 5 μ in length and breadth. Chromatophores numerous; in other respects similar to the typical form.

Trachelomonas acanthostoma Stokes. Plate 1, fig. 15.

Shell brown, dotted; 42.5 μ in length, 34 μ in breadth. Flagella hole, 5.1 μ in breadth. Chromatophores numerous.

Trachelomonas teres Maskell var. **glabra** var. nov. Plate 1, fig. 16.

Shell brown, smooth, without a neck; length, 37.7 μ, breadth, 25.5 μ. Flagella hole, 3.4 μ in breadth. Chromatophores numerous; in other respects similar to the typical form.

Trachelomonas orienburgica Swirenko var. **hypacantha** var. nov. Plate 1, fig. 17.

Shell oval, brown, dotted, covered with spines in the upper part; 27.2 μ in length, 17 μ in breadth. Neck, 2.5 μ in breadth. Chromatophores numerous.

Trachelomonas oblonga Lemmermann.

Shell brown, 15.3 μ in length, 10.2 μ in breadth. Flagella hole, 1.7 μ in breadth.

Trachelomonas oblonga var. **punctata** Lemmermann. Plate 1, fig. 19.

Shell brown, dotted; 22.1 μ in length, 13.6 μ in length. Flagella hole, 2.5 μ.

Trachelomonas nobilis Skvortzow var. **paludosa** var. nov. Plate 1, fig. 10.

Shell oval, brown, covered with knobs; 20.4 μ in length, 15.3 μ in breadth. Flagella hole, 1.7 μ in length, 5.1 μ in breadth. Chromatophores numerous.

Trachelomonas armata (Ehrenberg) Stein.

Shell, 35 μ in length, 28 μ in breadth. Rare.

Trachelomonas armata (Ehrenberg) Stein var. **rotunda** var. nov. Plate 1, fig. 9.

Shell broad-oval, brown, dotted; 39.1 μ in length (without spines), 37 μ in breadth. Flagella hole, 4.2 μ in breadth. The upper part with small spines, the lower part with large spines.

Trachelomonas armata (Ehrenberg) Stein var. **brachycentra** var. nov. Plate 1, fig. 18.

Shell broad-oval, brown, dotted, and covered with spines; length, 45 μ; breadth, 37 μ. Flagella hole, 5 μ in breadth. End spine short.

Trachelomonas armata (Ehrenberg) Stein var. **rigens** var. nov. Plate 1, fig. 20.

Shell broad-oval, smooth; 49.9 μ in length, 35.4 μ in breadth. Flagella hole, 4.2 μ in breadth. The upper and the lower part of the shell covered with spines. Chromatophores numerous.

Trachelomonas heterospina Swirenko var. **armata** var. nov. Plate 1, fig. 21.

Trachelomonas helvetica Lemmermann var. *armata* Skvortzow.

Shell brown, covered with spines; 37.4 μ in length, 17 μ in breadth. Flagella hole, 4 μ in breadth, with large spines. Chromatophores numerous.

Trachelomonas hispida (Petry) Stein var. **crenulatocollis** (Maskell) Lemmermann. Plate 1, fig. 22.

Shell brown, 35.7 μ in length, 25.5 μ in breadth. Flagella hole, 3.4 μ in breadth. Chromatophores numerous.

Trachelomonas crebea Kellicott var. **punctata** var. nov. Plate 1, fig. 23.

Shell brown, dotted; 39.1 μ in length, 23.8 μ in breadth. Flagella hole, 5 μ in length and breadth; in other respects similar to the typical form.

Trachelomonas ianczowskii Drezepolskii. Plate 1, fig. 24.

Trachelomonas pulchra Swirenko var. *bispinosa* Skvortzow.

Trachelomonas ianczowskii var. **decorata** var. nov.

Shell brown, dotted, covered with small spines; 37.4 μ in length, 34 μ in breadth. Flagella hole, 4.2 μ in breadth. Chromatophores numerous; in other respects similar to the typical form.

Trachelomonas intermedia Dangeard. Plate 1, fig. 26.

Shell brown, dotted; 18.7 μ in length, 15 μ in breadth. Flagella hole, 2.2 μ in breadth.

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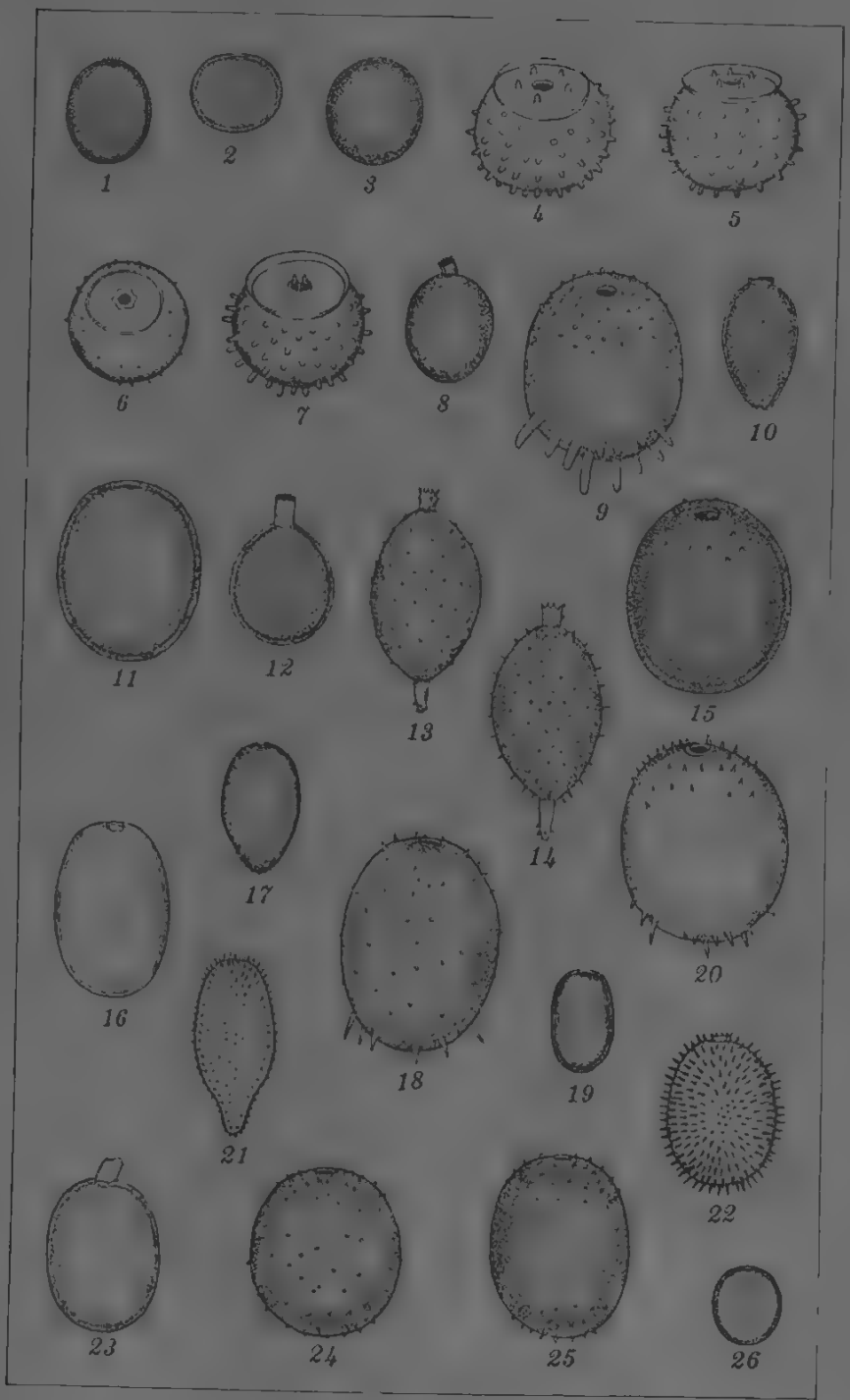

PLATE I.

FAUNA SAMARENSIS: COLEOPTERA, BUPRESTIDÆ

By W. S. FISHER

Of the Bureau of Entomology, United States Department of Agriculture

In working over the buprestid material from a rather extensive collection of Coleoptera collected by R. C. McGregor on Samar Island, Philippines, during May and June, 1924, several undescribed forms were found. As few species of Buprestidæ have been recorded from Samar, it seems advisable to include a list of those previously described. Nearly all of the species known to occur on this island are represented in the collection of the United States National Museum, some of this material having been previously sent to the museum by Prof. Charles Fuller Baker, University of the Philippines, Los Baños, Philippine Islands.

Castalia obsoleta Chevrolat.

Strigoptera obsoleta CHEVROLAT, Rev. Zool. (1841) 221.

There are several females of this species in the United States National Museum which were collected on Samar by the J. B. Steere Expedition. This species shows a striking sexual dichromatism; the females are much larger, more robust, and with a large orange-red spot on each elytron, while the males are much smaller and slenderer, and the elytra are without spots.

Chrysochroa (Chrysochroa) fulminans Fabricius.

Buprestis fulminans FABRICIUS, Mant. Ins. 1 (1787) 178.

Specimens of this species were collected on Samar by the J. B. Steere Expedition, and among the material received from R. C. McGregor were four specimens collected on the same island during May, 1924. All of the specimens examined from this island are very uniform in coloration, the dorsal surface is green, with a distinct golden tinge when viewed in certain lights, scarcely any blue reflection on the pronotum, and the tips of the elytra are only narrowly margined with a bright reddish cupreous color.

Epidelus wallacei Thomson.

Chalcophora wallacei THOMSON, Arch. Ent. 1 (1857) 109–110.

There is one female of this species in the United States National Museum from Samar, collected by C. F. Baker (*Baker 22544*). This specimen differs slightly from examples from Borneo, the type locality. It is more robust, dorsal surface green, with a slight golden tinge on the pronotum, and without a distinct cupreous tinge, head not fiery red, and the legs darker blue. It is the variety described by Saunders [1] as *philippinensis*.

Iridotaenia cupreomarginata Saunders.

Iridotaenia cupreomarginata SAUNDERS, Trans. Ent. Soc. London (1874) 304–305.

A male of this species was collected by C. F. Baker on Samar (*Baker 22543*) and sent to the United States National Museum.

Chrysodema (Thymedes) flavicornis Saunders.

Chrysodema flavicornis SAUNDERS, Trans. Ent. Soc. London (1874) 306–307.

A single female was collected by R. C. McGregor on Samar, June 5, 1924.

This species is easily distinguished from all other species of the genus in having the marginal carina of pronotum sharply defined and extending to the anterior margin. Waterhouse has made this species the type of his subgenus *Thymedes*.

Chrysodema cavifrons sp. nov.

Female.—Form oblong-oval, attenuate in front and more acuminate behind, and moderately convex; when viewed in profile, the ventral surface is nearly straight to apical third, then strongly attenuate to apex, the dorsal surface feebly arcuately rounded; head violaceous black, with the lateral margins, anterior margin, and punctures golden green; pronotum and elytra with the depressed areas and punctures golden green, and the reliefs violaceous black; beneath golden green, the legs slightly more bluish green, with a feeble violaceous tinge.

Head with a deep, concave depression on the front and vertex, the concavity extending to margin of eyes, and with a longitudinal groove extending the entire length, the groove deeply impressed on the front; surface slightly uneven, with a slight,

[1] Trans. Ent. Soc. London (1874) 314.

obtuse elevation behind the antennal cavities, and rather deeply irregularly punctate, the punctures dense and somewhat confluent along the eyes, becoming finer and more inconspicuous in the concave area, and without distinct pubescence; epistoma broadly, arcuately emarginate in front; antennæ black, except first two joints which are bronzy green, and the surface clothed with a few inconspicuous hairs.

Pronotum moderately convex, slightly more than one-half wider than long, distinctly narrower in front than behind, and widest at basal half; marginal carina slightly sinuate, and not attaining the apical angle; sides nearly parallel from base to apical third, then strongly narrowed to the apical angles, where they are feebly constricted; anterior margin arcuately emarginate, and without a distinct median lobe; base transversely truncate; surface with a feeble elevation on each side near lateral margins, a round, shallow depression on each side near base midway between the median carina and lateral margin, a narrow, smooth, median carina extending from base to anterior margin, deeply, coarsely punctate, the punctures confluent in some places, very irregularly distributed, causing numerous, irregular, smooth reliefs, and without distinct pubescence. Scutellum wider than long, rectangular, and the surface nearly smooth.

Elytra rather strongly convex, without basal depressions, and wider than pronotum at base; sides arcuately rounded from base to near middle where they are broadly, feebly constricted, then arcuately attenuate to the tips which are rather acute, the margins very coarsely serrate at apical half; humeral angles broadly rounded; each elytron with four distinct broad costæ, not including the sutural elevation which is longitudinally divided behind the scutellum; first costa entire, extending from base to apex, and parallel to the sutural margin; second costa sinuate anteriorly, and extending from base to near apex, where it is connected to the first costa; third costa short, extending from behind the humerus to apical fourth, and parallel with the marginal costa; and a marginal costa extending from the humeral angle to apex, and parallel with the lateral margin; there are also indications of a short costa at base between the second and third costæ; all of the costæ are about an equal distance apart, smooth on top, and with a few large punctures irregularly distributed; intercostal spaces with a few irregular,

transverse reliefs, especially in basal region, densely punctate, the punctures large, irregularly distributed, and more or less confluent, and the surface without conspicuous pubescence.

Abdomen coarsely punctate, the punctures sparsely placed on the median part of the basal segments, but becoming denser and more or less confluent toward the sides and apex, densely clothed with fine, erect, inconspicuous hairs, and the intervals finely reticulate; first segment broadly, longitudinally concave at middle; last segment broadly rounded at apex and without any emargination; rest of body beneath deeply and irregularly punctate, the punctures coarse and widely separated at the middle but becoming denser and more confluent toward the sides.

Length, 25 millimeters; width, 9.5.

Type locality.—Samar Island, Philippines.

Type.—Catalogue No. 28741, United States National Museum.

Described from a single female collected at the type locality by R. C. McGregor on June 21, 1924.

This species is allied to *eximia* Castelnau and Gory and to *dohrni* Saunders. From the former it differs in having the head violaceous black, basal joints of antennæ green, margins of pronotum and elytron not cupreous, and the underside of body green, without a distinct cupreous tinge. From *dohrni* it can be distinguished by the head and reliefs on dorsal surface being violaceous black, and the underside of body green.

Chrysodema samarensis sp. nov.

Female.—Similar in form to *cavifrons* Fisher; head violaceous black, with the lateral margins, anterior margins, and punctures golden green; pronotum and elytra with the reliefs violaceous black, the punctures golden green, lateral margins of pronotum and lateral margins of elytra posteriorly slightly cupreous, and the entire dorsal surface with a distinct, bright, bronzy tinge when viewed in certain lights; beneath golden green, with a distinct cupreous reflection.

Head with a deep, oblong depression on the front and vertex, the concavity extending to margin of eyes, and with a longitudinal groove extending from the occiput to near the epistoma, the groove wider and more deeply impressed on the front but becoming only feebly impressed on the occiput; surface slightly uneven, with two irregular ridges behind the antennal cavities, and irregularly punctate, the punctures coarse and somewhat confluent along the eyes, and becoming sparsely and very irreg-

ularly placed in the concave area, and clothed with very fine, long, erect hairs along the eyes; epistoma broadly, arcuately emarginate in front; antennæ black, except the first two joints, which are cupreous, and each joint armed with a few long hairs.

Pronotum moderately convex, one-half wider than long, distinctly narrower in front than behind, and widest at base; marginal carina feebly sinuate and not attaining the apical angles; sides feebly arcuately narrowed from base to apex, where they are feebly constricted; anterior margin arcuately emarginate, and without a distinct median lobe; base nearly truncate; surface at the sides slightly protruding, but not obscuring the marginal carina, with a broad, shallow depression (slightly interrupted at middle) on each side, from which extends a narrow depression obliquely forward to the apical angle, with a broad, smooth, median carina extending from base to anterior margin, deeply, coarsely punctate, the punctures somewhat confluent, very irregularly distributed, causing numerous, irregular, smooth reliefs, and without conspicuous pubescence. Scutellum wider than long, trapezoidal in form, and the surface nearly smooth.

Elytra rather strongly convex, without basal depressions, and wider than pronotum at base; sides nearly parallel and more or less sinuate to apical third, then strongly, arcuately attenuate to the tips, which are acute, and the lateral margins very coarsely serrate from near middle to apex; humeral angles obtusely rounded or subangulate; each elytron with four rather broad costæ, not including the sutural elevation, the costæ much confused in the basal region, and with longitudinal intercostæ, which are nearly as strongly elevated as the costæ, and connected transversely by irregularly placed reliefs, the intercostal depressions finely, densely, and very irregularly punctate, and the surface without distinct pubescence.

Abdomen densely and finely punctate, except on the median part of the two basal segments, where the punctures are coarse and widely separated, on rest of surface they are irregularly distributed, more or less confluent in some areas, and the surface is densely clothed with fine, moderately long, semierect hairs; first segment broadly, longitudinally concave at middle; last segment rather acute at apex, with a small, angular emargination at the tip.

Male.—Differs from the female in having the antennæ longer and slenderer, last abdominal segment with a large, deep, an-

gular emargination at the tip, middle tibiæ and femora densely clothed with long, cinereous pubescence on the underside, and with an elongate spot of similar pubescence on the inner margin of the posterior coxæ.

Length, 22 to 28 millimeters; width, 8 to 10.

Type locality.—Samar Island, Philippines.

Type, allotype, and paratypes.—Catalogue No. 28742, United States National Museum. Paratypes returned to R. C. McGregor; there are also examples of this species in the collection of C. F. Baker, under his number 22542.

Described from twenty-two examples (twenty-one females and one male). Type (female), allotype, and nineteen paratypes collected at the type locality by R. C. McGregor during June and July, 1924, and one paratype collected by C. F. Baker on the same island (*Baker 22542*).

This species is closely allied to *Chrysodema antennata* Saunders, but can be distinguished from that species by the absence of coppery spots on the elytra, and the reliefs of a violaceous black color; in *antennata* the reliefs are bronzy green, and each elytron is ornamented with two coppery yellow spots, one just behind the humerus and the other behind the middle. It also resembles *Chrysodema granulosa* Kerremans and *Chrysodema hebes* Kerremans, but both of these species are described as having the antennæ glabrous. The species is very uniform in coloration and has a distinct coppery bronze tinge when viewed in certain lights.

Dicercomorpha albosparsa var. nigroviridis var. nov.

Differs from the typical *albosparsa* Castelnau and Gory in being of a brilliant dark green color, and not black; round pubescent spots on elytra larger than those shown in the figure of that species; sides of pronotum angulated, and not rounded, and the pubescent spots on underside of abdomen white instead of yellow, as given for *albosparsa*.

Length, 19 to 24 millimeters; width, 7.5 to 9.5.

Type locality.—Samar, Philippines.

Other localities.—Butuan, Mindanao, Philippines.

Type and paratypes.—Catalogue No. 28743, United States National Museum. Paratype returned to R. C. McGregor; there are also examples of this variety in the collection of C. F. Baker under his number 14551.

Described from seven examples. Five (one, type) were collected at the type locality by R. C. McGregor on May 30 and

June 1, 1921; one from Butuan, Mindanao, collected by C. F. Baker (*Baker 14551*); and one old specimen in the United States National Museum, labeled "Philippine Islands, E. A. Mearns." The last-mentioned specimen was probably collected on the Mearns Expedition to Mount Apo, Mindanao.

This beautiful variety is very uniform in markings and coloration, except that the specimens from Mindanao are slightly darker than are those from Samar. The typical form of *albosparsa* was described from Java and, after examining a series of specimens from the Philippines, it seems advisable to give this form a new name.

Chrysobothris pictiventris Saunders.

Chrysobothris pictiventris SAUNDERS, Trans. Ent. Soc. London (1874) 316–317.

One specimen in the United States National Museum collected by R. C. McGregor on Samar, May 30, 1924.

Belionota sagittaria Eschscholtz.

Belionota sagittaria ESCHSCHOLTZ, Zool. Atlas, pt. 1 (1829) 9–10, pl. 4, fig. 5 (reprint pp. 8–9).

This species was described from Manila, and seems to have a wide distribution in the Philippines. In the United States National Museum are specimens of this species received from C. F. Baker from Sibuyan Island, Palawan, Mindanao, and recently the museum has received ten specimens collected on Samar by R. C. McGregor during the latter part of May and the beginning of June, 1924.

Belionota fallaciosa H. Deyrolle.

Belionota fallaciosa H. DEYROLLE, Ann. Soc. Ent. Belg. 8 (1864) 84–85.

This is also a common species and it has been recorded from a number of islands in the Philippines. In the United States National Museum are nine examples collected by R. C. McGregor on Samar during May and June, 1924.

Amorphosomus marmoreus H. Deyrolle.

Amorphosomus marmoreus H. DEYROLLE, Ann. Soc. Ent. Belg. 8 (1864) 127, pl. 4, fig. 14.

A single example of this species was collected on Samar by R. C. McGregor on June 8, 1924.

Cryptodactylus philippinensis Saunders.

Cryptodactylus philippinensis SAUNDERS, Trans. Ent. Soc. London (1874) 321–322.

This species is represented in the United States National Museum by a single example collected on Samar by R. C. McGregor on June 1, 1924.

Cisseicoraebus grandis Kerremans.

Coraebus grandis KERREMANS, Mem. Soc. Ent. Belg. 7 (1900) 77 (separate p. 17).

This species was described from Samar by Kerremans, but no specimen from that island has been examined by me.

Agrilus occipitalis Eschscholtz.

Buprestis occipitalis ESCHSCHOLTZ, Entomographien (1822) 79–80.

This species was described from near Manila, Luzon, by Eschscholtz, but there is a single male in the United States National Museum collected on Samar by R. C. McGregor on May 31, 1924.

Agrilus megregori sp. nov.

Female.—Form elongate and moderately robust, subopaque; head blackish green; pronotum cupreous, with a distinct aureous tinge; elytra olivaceous green; beneath bronzy green, and slightly more shining than above.

Head with the front rather narrow, feebly convex, distinctly narrower at base than at apex, with a slight longitudinal depression at vertex, a broad, obsolete depression behind the epistoma, and a narrow longitudinal groove extending from the occiput to near the epistoma; lateral margins strongly, obliquely narrowed from the base to vertex, where they are arcuately rounded, then nearly parallel to the apex; surface coarsely punctate, densely, coarsely rugose, the rugæ transverse in front but becoming concentrical on each side of the occiput, and sparsely clothed with short, erect, inconspicuous hairs; epistoma wide between the antennæ, and nearly truncate in front; antennæ aëneous, extending nearly to middle of pronotum, serrate from the fourth joint, and the outer joints slightly wider than long; eyes large, strongly convex laterally, and more broadly rounded beneath than above.

Pronotum one-half wider than long, base and apex about equal in width, and widest in front of middle; sides feebly, arcuately rounded from apex to behind the middle; then more obliquely

narrowed to the posterior angles, which are rectangular; when viewed from the side the marginal carina is strongly sinuate, the submarginal carina strongly sinuate and obliterated anteriorly, the two carinæ widely separated at middle and connected to each other near base; anterior margin strongly sinuate, with the median lobe broadly rounded; base feebly emarginate at the middle of each elytron, and the median lobe broadly truncate in front of scutellum; disk moderately convex, without distinct median depression but with a broad, deep depression on each side extending from the lateral margin obliquely backward to near the base, and a sharply defined arcuate prehumeral carina extending from the base to the marginal carina near middle; surface with densely placed, transverse asperities, and the intervals with numerous fine punctures, from which arises a short, erect, inconspicuous hair. Scutellum with a sharply defined, sinuate, transverse carina, and the surface densely reticulate.

Elytra slightly wider than pronotum at base, and about equal in width at base and just behind the middle; sides nearly parallel for a short distance behind the base, rather strongly, broadly, arcuately constricted in front of middle, broadly, arcuately expanded behind the middle, then obliquely narrowed to the tips which are produced into a long spine at the middle of each elytron; sides of abdomen broadly exposed above; disk rather strongly convex, feebly, broadly flattened on median part and along sutural margins toward apex, and with broad, shallow basal depressions; surface densely, finely imbricate-punctate, becoming coarsely granulose toward the base, and sparsely clothed with fine, inconspicuous hairs.

Abdomen beneath sparsely, finely punctate, becoming transversely rugose on basal segment, and sparsely clothed with short, recumbent, cinereous hairs; first and second segments convex at middle and without a median groove; last segment broadly rounded at apex; vertical portions of segments rather densely clothed with long, recumbent, golden yellow pubescence; pygidium longitudinally carinate but the carina not projecting. Episternum and lateral side of posterior coxæ densely clothed with long, recumbent, golden yellow pubescence. Prosternum rather densely, coarsely granulose, and sparsely clothed with short, semierect, cinereous hairs; prosternal lobe broad, moderately declivous, and broadly rounded in front, with a broad, deep, arcuate emargination at the middle; prosternal process broad, the sides parallel to behind the coxal cavities, then oblique-

ly narrowed to the apex which is acute. Tibiæ slender, straight, anterior and middle pairs with a short tooth on the inner margin at apex, and the anterior pair simple. Posterior tarsi distinctly shorter than tibiæ, and the first joint about equal in length to the following three joints united. Tarsal claws similar on all feet, cleft near the middle, the teeth nearly equal in length, and the inner tooth slightly turned inward at the tip, but the tips widely separated.

Length, 7 millimeters; width, 2.

Type locality.—Samar Island, Philippines.

Type.—Catalogue No. 28744, United States National Museum.

Described from a single female collected by R. C. McGregor on Samar, Philippines, on June 21, 1924.

This species is closely allied to *quadriplagiatus* Fisher and *spinellifer* Obenberger. From the former it can be distinguished by the absence of pubescent spots on the elytra, and from the latter in having the elytra of a uniform olivaceous green color, and the pronotum with distinct prehumeral carinæ.

Sambus auricolor Saunders.

Sambus auricolor SAUNDERS, Trans. Ent. Soc. London (1874) 322–323.

This species was described from Samar by Edward Saunders, but no specimen from that island has been examined by me.

DIE STAPHYLINIDEN DER PHILIPPINEN

21. BEITRAG ZUR INDO-MALAYISCHEN STAPHYLINIDENFAUNA

Von MAX BERNHAUER

Öff. Notar in Horn, Nied. Oesterreich

In den letzten Jahren erhielt ich von unserem bekannten Philippinenforscher Prof. C. F. Baker eine reiche Auslese seiner Staphylinidenausbeute von den Philippinen mit vielen neuen Arten. Ausserdem übergab mir die grosse Naturalienhandlung Dr. O. Staudinger & A. Bang-Haas aus Blasewitz-Dresden eine überaus grosse und reichhaltige Staphylinidensammlung des Herrn Böttcher von den Philippinen, in welcher sich ebenfalls eine ganze Reihe neuer Arten befanden, so dass sich bereits ein recht anschauliches Bild der Philippinischen Staphylinidenfauna ergibt.

Ich will daher nunmehr daran gehen, nach und nach Bestimmungstabellen der einzelnen Genera zu verfassen und sie der Oeffentlichkeit übergeben.

Tribus PIESTINI

Genus EUPIESTUS Kraatz

1. Halsschildrippen glänzend, Körper klein, 2.5 Millimeter. LUZON, Burauen; Mount Banahao (*Böttcher*). MINDANAO, Provinz Lanao, Iligan (*Baker*) ..... E. sculpticollis Kraatz.
   Halsschildrippen nicht glänzend, Körper grösser, 2.8 bis 3.5 Millimeter ..... 2.
2. Weib, Flügeldecken viel länger als der Halsschild, pechbraun mit etwas rötlichen Flügeldecken, die Wurzel der Fühler, die Taster und Beine rostgelb. Kopf schmäler als der Halsschild mit grossen ziemlich vorgequollenen Augen, hinter diesen plötzlich verengt mit sehr kurzen Schläfen, die Scheitelfurche unbestimmt. Fühler kurz, vom fünften Gliede an stärker erweitert, dieses und die folgenden Glieder quer, das Endglied konisch. Halsschild länger als breit mit spitzigen Vorder und Hinterecken, der Seitenzahn ebenfalls spitzig. Flügeldecken um ein gutes Stück länger als der Halsschild und viel breiter als dieser, etwas länger als zusammen breit, ziemlich glänzend mit feinen Rippen und sehr breiten, weitläufig punktierten Zwischenräumen. Hinterleib ziemlich fein und dicht punktiert und schwach

beschuppt. Länge, 2.8 Millimeter. LUZON, Provinz Nueva Vizcaya, Imugan (*Böttcher*). Ein einziges Weib..... **E. luzonicus sp. nov.**

Flügeldecken wenig länger als der Halsschild, Augen flach, nicht vorragend, Seitenzahn des Halsschildes stumpf verrundet..... 3.

3. Körper grösser, 3.5 Millimeter, Fühler länger, die vorletzten Glieder beim Mann viel länger als breit, beim Weib so lang als breit. LUZON, Mount Banahao: Provinz Nueva Vizcaya, Imugan. MASBATE, Aroroy (*Böttcher*)..... **E. longicornis Fauvel.**[1]

Körper kleiner, 3 bis 3.2 Millimeter, Fühler kürzer, die vorletzten Glieder beim Mann so lang als breit, beim Weib stark quer, Kopf mit deutlichen, nach hinten nicht erweiterten Schläfen, der Seitenzahn des Halsschildes nur als flacher Vorsprung angedeutet, der Körper bei reinen Stücken dicht grau beschuppt, matt. LUZON, Mount Maquiling, Mount Banahao (*Baker*)..... **E. philippinus sp. nov.**

Genus ELEUSIS Castelnau

1. Kopf hinten scharf quer gefurcht, der Scheitel erhoben und durch eine kurze scharfe Furche in zwei Teile geteilt. Färbung heller oder dunkler rostfarben, der hintere Teil der Flügeldecken und oft ein Gürtel vor der Spitze dunkler..... 2.

Kopf hinten höchstens mit einer sehr feinen Querlinie..... 6.

2. Die seitlichen Kopffurchen hinter den Augen nach aussen gebogen.... 3.

Die seitlichen Kopffurchen fast gerade streichend..... 5.

3. Sehr grosse Art, der Halsschild fast dreimal breiter als lang, der Vorderrand mit zwei ziemlich tiefen Ausrandungen, der Kopf stark nach rückwärts erweitert. Rostbraun bis hell rostrot, die hintere Partie der Flügeldecken breit schwarz bis pechbraun, die Beine rostrot. Kopf beim Mann meist breiter, beim Weib meist etwas schmäler als der Halsschild, ziemlich matt chagriniert, sehr fein, aber deutlich und namentlich rückwarts nicht allzu weitläufig punktiert, die Scheitelfurchen tief und ziemlich breit, die Furche neben den Augen reicht viel weiter nach rückwärts als der grosse Schläfenpunkt. Halsschild vorn tief zweibuchtig, die Gestalt eines flachen Kreisabschnittes bildend, die Hinterecken durch einen grossen, durch einen Einschnitt des Seitenrandes gebildeten Zahnes angedeutet, meist mit zwei breiten, flachen Eindrücken, fein und namentlich in der Mitte nicht zu weitläufig punktiert, ähnlich wie der Kopf gestrichelt, am Vorderrand jederseits mit zwei grossen Punkten und einem scharfen schiefen Strich. Flügeldecken länger als der Halsschild, auf der Scheibe mit zwei hinter einander stehenden Punkten, viel weitläufiger gestrichelt, ziemlich glänzend, fein und weitläufig punktiert, neben dem Seitenrand mit einer Längsfurche, deren äusserer Rand wulstförmig erhoben ist. Hinterleib mit einzelnen Punkten, äusserst fein quergestrichelt. LUZON, Provinz Nueva Vizcaya, Imugan (*Böttcher*). Länge, 8 bis 11 Millimeter..... **E. phaenomenalis sp. nov.**

Mittelgrosse Arten, der Halsschild ungefähr doppelt so breit als lang,

[1] Ob diese Art tatsächlich mit der aus Sumatra beschriebenen *longicornis* identisch ist, kann ich mit vollster Sicherheit nicht feststellen, da mir diese Art bisher fehlte. Die Beschreibung stimmt in allen Punkten überein.

mehr oder minder halbkreisförmig, der Vorderrand schwächer zweibuchtig, die Färbung meist heller, mehr rötlichgelb, der Kopf nach rückwarts höchstens schwach erweitert..... 4.

4. Halsschild etwas mehr als doppelt so breit als lang, nicht ganz halbkreisförmig, der Kopf beim Mann schwach erweitert, beim Weib nach rückwärts gerundet verengt, die Augenfurchen sammt dem Längswulst weiter nach rückwärts reichend als der grosse Schläfenpunkt, die Längsfurche am Scheitel stärker, die Flügeldecken meist mit zwei Punkten, seltener mit einem Punkt und dann zugleich kürzer. Halsschild dichter gestrichelt, matter. Länge, 6 bis 8 Millimeter. LUZON, Provinz Nueva Vizcaya, Imugan: Provinz Mountain, Mount Polis; Balbalan..... **E. luzonicus sp. nov.**

Halsschild kaum doppelt so breit als lang, fast ganz halbkreisförmig, der Kopf nach rückwärts nicht erweitert, die Augenfurchen nur bis zu dem Schläfenpunkt reichend, die Längsfurche am Scheitel schmäler und weniger tief, die Flügeldecken nur mit einem Punkt, zusammen nur wenig länger als breit. Halsschild weitläufig gestrichelt und stark glänzend. Länge, 5 bis 6 Millimeter. LUZON, Mount Banahao (*Baker*): Provinz Nueva Vizcaya, Imugan (*Böttcher*)..... **E. sulciceps sp. nov.**

5. Von der Grösse und Färbung des *luzonicus* m., die letztere ebenso veränderlich vom rostgelb bis zum dunklen rostbraun, der Kopf länger, nach hinten unmerklich (Mann) oder gar nicht (Weib) erweitert, mit kleineren Augen und viel längeren Schläfen, die seitlichen Kopffurchen neben den Augen und die an deren Aussenseiten abgesetzten Kiele geradlinig nach hinten verlaufend und nur bis zum grossen Schläfenpunkt reichend. Halsschild weniger kurz, nicht ganz doppelt so breit als lang, die Ausbuchtung an den Seiten und die dadurch gebildeten Zähne viel stärker. Länge, 7.5 bis 8.5 Millimeter. LUZON, Provinz Mountain, Pauai (Haight's Place); Mount Polis (*Böttcher*)..... **E. augustae sp. nov.**

6. Kopf beim Mann nach rückwärts stark, beim Weib nur schwach oder kaum erweitert, so breit als lang, äusserst fein gestrichelt und fein und spärlich, längs dem Hinterrande dichter punktiert, die Augenrandfurche sehr lang und scharf und aussen scharfgekielt, in der Mittellinie ist eine schwache Längsfurche angedeutet. Der Kopf ist beim Mann breiter als der Halsschild, beim Weib so breit oder sogar etwas schmäler als dieser. Halsschild wenig dicht gestrichelt, stark glänzend, sehr spärlich und äusserst fein punktiert, fast um die Hälfte breiter als lang, das Seitenzähnchen scharf, die Mittellinie äusserst schmal kielförmig erhoben. Flügeldecken nur wenig länger als der Halsschild, zusammen so lang als breit, nach rückwärts schwach erweitert, äusserst fein und spärlich gestrichelt und kaum wahrnehmbar punktiert, stark glänzend. Hinterleib ausser den normalen Basalpunkten an den Seiten der Tergite mit einigen wenigen Punkten. Pechbraun, die Flügeldecken bis auf den schwärzlichen Spitzenrand schwärzlich, Fühler, Taster und Beine dunkel rostrot. Länge, 3.5 bis 5 Millimeter. LUZON, Provinz Laguna, Los Baños (*Böttcher*)..... **E. divergens sp. nov.**

Kopf auch beim Mann nach rückwarts nicht oder nur wenig erweitert ..... 7.

7. Flügeldecken zusammengenommen höchstens um ein Drittel länger als breit ..... 8.
   Flügeldecken zusammengenommen mindestens um die Hälfte länger als breit ..... 34.
8. Kopf wenigstens beim Mann gleichbreit, rechteckig ..... 9.
   Kopf bei beiden Geschlechtern rundlich, meist deutlich breiter als lang ..... 19.
9. Kopf länger als breit (von der Mitte des Clypeus bis zum Halsschildrande gemessen) ..... 10.
   Kopf nicht länger als breit ..... 17.
10. Hinterleib äusserst dicht und stark lederartig gewirkt, matt, Kopf vor dem Hinterrande mit einem schwachen Quereindruck ..... 11.
    Hinterleib weitläufig gestrichelt, glänzend, Kopf ohne Quereindruck am Halse ..... 13.
11. Vorderkörper sehr stark glänzend, bei Lupenvergrösserung ohne erkennbare Strichelung. Schwarz, die Fühler, Taster und Beine, sowie die Flügeldecken bis auf den breiten dunklen Hinterrand rötlichgelb. Kopf regelmässig rechteckig, fein und weitläufig punktiert, die Augenrandfurche sehr weit nach rückwärts reichend, die vorletzten Fühlerglieder schwach quer. Halsschild um ein Viertel breiter als lang, mit einem scharfen Zähnchen hinter der Mitte, auf der Scheibe kräftiger, aber nicht dichter als den Kopf punktiert. Flügeldecken um ein Drittel länger als breit, mit einem grösseren Punkt und einer Anzahl sehr feiner Pünktchen, ohne Chagrinierung. Länge, 3.6 mm. LUZON, Provinz Mountain, Balbalasang (*Böttcher*). Ein einziges Stück ..... **E. speculipennis** sp. nov.
    Vorderkörper wenig glänzend, sehr deutlich und sehr dicht gestrichelt ..... 12.
12. Flügeldecken ungefähr um ein Viertel länger als breit, die dunkle Partie auf der hinteren Hälfte ungefähr ein Drittel der Länge einnehmend, Vorderkörper deutlich weitläufig punktiert, Kopf deutlich länger, das seitliche Halsschildzähnchen grösser und spitziger, die Färbung ähnlich wie bei dem vorhergehenden, die Beine jedoch etwas angedunkelt, der Kopf nach rückwarts vollkommen gleichbreit, der Körper breiter und grösser. Länge, 5 Millimeter. LUZON, Provinz Mountain, Mount Polis (*Böttcher*). Ein einziges Stück.
    E. quadraticeps sp. nov.
    Flügeldecken nur ungefähr ein Fünftel länger als breit, die dunkle Apicalpartie die Hälfte der Länge einnehmend, Vorderkörper ohne deutliche Punktierung, Kopf kürzer, nur sehr wenig länger als breit, nach rückwarts äusserst schwach verbreitert, die dunkle Färbung mehr pechbraun, Beine angedunkelt, Körper schmäler und kleiner. Länge, 4.5 Millimeter. LUZON, ein Stück vom gleichen Fundorte.
    E. alutiventris sp. nov.
13. Kopf deutlich und ziemlich dicht, wie mit einer Nadel scharf geritzt ..... 14.
    Kopf nicht scharf nadelrissig, sondern gewöhnlich gestrichelt ..... 15.
14. Halsschild auf der Scheibe ohne Strichelung, glänzend glatt, der Kopf stellenweise weitläufiger geritzt, die vorletzten Fühlerglieder deutlich quer. Körper grösser und breiter. Grundfärbung heller oder dunkel

pechfarben, vom dunklen pechbraun bis zum schmutziggelb, der Kopf aber immer etwas dunkler, die Flügeldecken bis auf den dunklen Hinterrand rötlichgelb. Länge, 3.5 bis 4 Millimeter. LUZON, Provinz Mountain, Lubuagan: Provinz Camarines Sur, Mount Isarog: Provinz Laguna, Los Baños: Provinz Ilocos Norte, Bangui. MINDANAO, Provinz Lanao, Mumungan (*Böttcher*). In einer Anzahl von Stücken erbeutet..... E. strigiceps sp. nov.

Halsschild mit feiner, aber deutlicher Strichelung, mässig glänzend, der Kopf viel dichter und gleichmässiger geritzt, vorn stellenweise quer gestrichelt, die vorletzten Fühlerglieder nicht breiter als lang. Körper etwas kleiner und schmäler. Grundfärbung, hell rötlichgelb mit schwach angedunkelter Apikalpartie der Flügeldecken. Länge, 3 bis 3.5 Millimeter. PALAWAN, Binaluan (*Böttcher*). Zwei Stücke. E. palawanensis sp. nov.

15. Körper grösser, Kopf auf der Mitte der Scheibe ohne Grundskulptur, stark glänzend, vorn ziemlich kräftig punktiert.... E. discalis Fauvel.

Körper kleiner, überall ziemlich dicht längsgestrichelt, wenig glänzend ..... 16.

16. Körper einfarbig bräunlich einschliesslich der Fühler und Taster, mit dunklerem Kopf; dieser nur sehr wenig länger als breit, die Schläfen nur wenig länger als der Längsdurchmesser der Augen. Halsschild deutlich quer, nach rückwarts gleichmässig gerundet verengt, ohne seitliches Zähnchen; die Flügeldecken viel länger als der Halsschild, um ein Drittel länger als zusammen breit. Länge, 3 Millimeter. MINDANAO, Provinz Lanao, Mumungan (*Böttcher*). Ein einziges Stück..... E. brunnea sp. nov.

Körper pechschwarz bis pechbraun mit rostfarbigen Fühlern und Beinen, die Flügeldecken hell rötlichgelb mit dunklem Hinterrande; Kopf viel länger als breit, biem Mann langgestreckt, regelmässig rechteckig, beim Weib mehr länglich eiförmig nach hinten sanft gerundet verengt, die Schläfen beim Mann viel, beim Weib wenig länger als der Längsdurchmesser der Augen; Halsschild fast länger als breit, nach rückwärts flacher verengt, mit deutlichem Seitenzähnchen; Flügeldecken nur wenig länger als der Halsschild, nur ungefähr ein Viertel länger als zusammen breit. Länge, 2.5 bis 3 Millimeter. LUZON, Provinz Camarines Sur, Mount Isarog: Provinz Bataan, Limay. MINDANAO, Provinz Lanao, Mumungan. PALAWAN, Binaluan. BASILAN. MINDORO, San Teodoro. MASBATE, Aroroy (*Böttcher*)..... E. angusticeps sp. nov.

17. Kopf heller oder dunkler gelb sowie der übrige Körper bis auf dem dunklen Hinterrand der Flügeldecken, der Hinterleib oft ganz oder teilweise etwas dunkler. Kopf beim Mann gleichbreit, so breit als der Halsschild, beim Weib mehr gerundet und etwas schmäler, in beiden Geschlechtern etwas breiter als lang, deutlich gestrichelt; Fühler ziemlich kurz, die vorletzten Glieder schwach quer. Halsschild so lang als breit, mit kaum angedeuteten seitlichen Zähnchen, stark glänzend, mit kaum wahrnehmbarer Strichelung. Flügeldecken wenig länger als zusammen breit. Länge, 2.5 Millimeter. LUZON, Provinz Camarines Sur, Mount Isarog: Provinz Laguna, Los Baños (*Böttcher*)..... E. flaviceps sp. nov.

Kopf schwarz..... 18.

27. Flügeldecken braun, die Färbung sonst pechschwarz, die Wurzel der bräunlichen Fühler, die Taster und Beine rötlichgelb, die Schenkel angedunkelt. Kopf beim Mann stark, beim Weib kaum breiter als der Halsschild, beim letzteren sofort hinter den Augen verengt, beim Mann ziemlich erweitert, kurz elliptisch oder fast kreisrund, sowie der übrige Körper stark lackglänzend. Fühler dünn, die vorletzten Glieder nicht quer. Halsschild beim Mann deutlich quer, beim Weib so lang als breit, Flügeldecken nur um ein Viertel länger als zusammen breit. Grundskulptur des ganzen Körpers äusserst schwach, schwer erkennbar. Länge, 3.2 bis 3.5 Millimeter. LUZON, Provinz Laguna, Los Baños (*Böttcher*)..... **E. circulieeps sp. nov.**

Flügeldecken rötlichgelb mit dunklerem Hinterrande..... 28.

28. Kopf ohne ocellenartige Beulchen, beim Mann viel breiter, beim Weib so breit als der Halsschild, Grundfärbung pechschwarz mit hellen Flügeldecken und rostbräunlichen Fühlern, Tastern und Beinen. Halsschild deutlich quer, ohne Seitenzähnchen, Flügeldecken nur wenig länger als breit, Fühler etwas kürzer, Grundskulptur deutlich dichter. Länge, 3 bis 3.5 Millimeter. LUZON, Burauen. MINDANAO, Provinz Zamboanga, Port Banga: Provinz Lanao, Mumungan (*Böttcher*)..... **E. splendida sp. nov.**

Kopf im hinteren Drittel mit zwei glänzend glatten, ocellenartigen Erhabenheiten, beim Weib schmäler als der Halsschild, Grundfärbung braunrot bis rötlichbraun, Flügeldecken hellgelb mit schwärzlichem Hinterrand, Fühler, Taster und Beine lebhaft rötlichgelb. Halsschild länger als breit mit deutlichen Seitenzähnchen. Flügeldecken viel länger als breit. Fühler länger und gestreckter, Grundskulptur weitläufiger, nicht gut sichtbar. Länge, 3 Millimeter. MINDANAO, Provinz Lanao, Mumungan. LUZON, Provinz Nueva Vizcaya, Imugan (*Böttcher*)..... **E. ocellatus sp. nov.**

29. Flügeldecken um ein Drittel länger als zusammen breit, lebhaft rotgelb, der Kopf, der rückwärtige vierte Teil der Flügeldecken und ein Gürtel vor der Hinterleibsspitze schwarz, die Oberfläche ohne Unebenheiten, gleichmässig flach gewölbt. Kopf beim Mann so breit als der Halsschild, beim Weib schmäler und kürzer, Halsschild so lang als breit, die Seitenzähnchen kaum angedeutet. Grundskulptur bei schärfster Lupenvergrösserung deutlich. Länge, nicht ganz 2.5 Millimeter. LUZON, Provinz Mountain, Balbalasang (*Böttcher*).

E. alternans sp. nov.

Flügeldecken höchstens um ein Viertel länger als zusammen breit.... 30.

30. Bräunlichgelb, meist mit schwach angedunkeltem Kopf, Halsschild, Flügeldeckenhinterrand und einem Gürtel vor der Hinterleibsspitze. Kopf beim Mann fast breiter, beim Weib schmäler als der Halsschild, beim Mann von der Gestalt eines fast regelmässigen Kreises mit sehr stark entwickelten Schläfen, welche doppelt so lang als der Längsdurchmesser der Augen sind, beim Weib quer, mit kurzen, aber immerhin deutlichen Schläfen; Halsschild fast so lang als breit, nach rückwärts fortlaufend in flachem Bogen verengt, der Seitenzahn nur durch einen Borstenpunkt angedeutet; Flügeldecken höchstens um ein Viertel länger als breit. Grundskulptur meist schwer erkennbar. Länge, 2.5 Millimeter. PALAWAN, Binaluan. MINDORO,

San Teodoro. MINDANAO, Provinz Lanao, Mumungan. LUZON, Provinz Camarines Sur, Mount Isarog (*Böttcher*)..... **E. soror sp. nov.**[4]

Kleiner, höchstens 2 Millimeter..... 31.

31. Körper winzig klein, 1 bis 1.3 Millimeter lang, Augen am Innenrande ohne Längsfurche..... 33.

Körper weniger klein, 2 Millimeter. Augen am Innenrande mit scharfer Längsfurche ..... 32.

32. Halsschild lebhaft rotgelb, deutlich quer:

a. Flügeldecken kaum länger als zusammen breit (Stammform). **E. philippinus Bernhauer.**

b. Flügeldecken um ein Viertel länger als zusammen breit. **E. philippinus var. longipennis var. nov.**

Halsschild rötlichbraun bis schwarz, so lang oder etwas länger als breit, ohne Seitenzähnchen, Kopf beim Mann breiter, beim Weib so breit als der Halsschild, Flügeldecken um ein Viertel länger als breit, ohne Punktierung, Grundskulptur am Kopf deutlich, am Halsschild und auf den Flügeldecken sehr undeutlich. Länge, 2 Millimeter. MINDANAO, Provinz Zamboanga, Port Banga: Provinz Lanao, Mumungan. PALAWAN, Binaluan (*Böttcher*)..... **E. pennata sp. nov.**

Flügeldecken um ein Drittel länger als zusammen breit. PALAWAN, Binaluan (*Böttcher*)..... **E. philippinus var. longelytrata var. nov.**

33. Kopf angedunkelt, deutlich und ziemlich dicht längsgestrichelt, weniger glänzend, beim Mann breiter, beim Weib so breit als der Halsschild, so lang als breit, Flügeldecken um ein Viertel länger als zusammen breit. LEYTE. PALAWAN, Binaluan. SIARGAO. MASBATE, Aroroy. (*Böttcher*)..... **E. fusciceps Kraatz.**

Kopf rötlichgelb, nicht oder undeutlich oder weitläufig längsgestrichelt, glänzend, beim Mann nicht oder kaum breiter als der Halsschild. Eine allem Anscheine nach sehr veränderliche Art, welche vielleicht bei Hervorkommen eines grösseren Materiales sich in mehrere Arten wird spalten lassen. Länge, 1 bis 1.3 Millimeter. SIARGAO, Dapa. PALAWAN, Binaluan. LUZON, Provinz Mountain, Balbalasang. MINDANAO, Provinz Lanao, Mumungan. MASBATE, Aroroy (*Böttcher*). **E. banghaasi sp. nov.**[5]

[4] Die Art ist etwas veränderlich und unterscheidet sich im weiblichen Geschlecht von der ähnlich gefärbten *kraatzi* Fauvel durch kleinere Augen und die immerhin deutlicheren Schläfen, beim Mann aber durch ganz andere Kopfbildung.

[5] Bei der typischen Form, welche etwas breiter ist, sind die Flügeldecken nur wenig länger als zusammen breit, der Halsschild etwas breiter als lang, der Kopf beim Mann so lang als breit, die Grundskulptur spärlich und kaum sichtbar, Oberseite sehr stark glänzend.

Bei den verschiedenen übrigen Formen werden die Flügeldecken länger, bis zu einem Drittel länger als breit, der Halsschild ist oft länger als breit, auch der Kopf des Mannes ist bisweilen viel länger als breit, die Grundskulptur ist eine veränderliche und oft sehr deutlich, aber immer spärlich, bisweilen tritt sie entgegen den übrigen Formen auf den Flügeldecken deutlich hervor (var. *exigua* m.).

Diese Formen gehen so bizarr durcheinander, das es erst auf Grund eines grossen Materiales möglich sein wird ein abschliessendes Urteil über eine allfällige Artberechtigung einzelner dieser Formen zu gewinnen.

34. Hinterleib glänzend, ziemlich weitläufig quergestrichelt, Kopf ziemlich stark quer, stark eingeschnürt, vor dem Halse scharf quergefurcht, bei beiden Geschlechtern viel breiter als der Halsschild, der Vorderkörper einschliesslich der Flügeldecken deutlich irisierend. Kopf und Halsschild äusserst fein und sehr spärlich punktiert. Flügeldecken mit je zwei in einer Längsreihe stehenden Dorsalpunkten. Grundskulptur am Kopf deutlicher, sonst sehr schwer sichtbar. Die vorletzten Fühlerglieder schwach quer. Augenfurchen kurz, hinten stark nach innen gebogen. Der Körper ist schwarz, die Flügeldecken bräunlichgelb, das hintere Drittel angedunkelt, Fühler, Taster und Beine rötlichgelb. Länge, 3.5 bis 4 Millimeter. MINDANAO, Provinz Zamboanga, Dapitan (*Baker*). LUZON, Provinz Mountain, Pauai (Haight's Place)..... **E. iridescens sp. nov.**[6]

Hinterleib ziemlich matt, sehr dicht lederartig gewirkt, vor dem Halse nicht scharf gefurcht, bei beiden Geschlechtern nicht oder nur wenig breiter als der Halsschild, der Vorderkörper nicht irisierend, Flügeldecken nur mit einem feinen Diskalpunkt..... 35.

35. Kopf ziemlich dicht und kräftig punktiert, beim Mann kaum länger als breit, rundlich, hinten abgeschnürt. Schläfen nicht doppelt so lang als der Längsdurchmesser der Augen, Halsschild deutlich, ziemlich kräftig punktiert, auf der hinteren Hälfte jederseits mit einem kurzen, aber tiefen Längseindruck. Grundskulptur stark und dicht. Färbung wie der vorige. Länge, 3.2 bis 3.5 Millimeter. LUZON, Provinz Mountain, Pauai (Haight's Place)..... **E. densiceps sp. nov.**

Kopf nicht oder nur einzeln punktiert, beim Mann viel länger als breit, hinter den Augen geradlinig, unmerklich erweitert, lang rechteckig, hinten nur wenig eingeschnürt. Schläfen mehr als doppelt so lang als der Längsdurchmesser der Augen. Beim Weib ist der Kopf viel kleiner, kürzer, mehr rundlich, mit kürzeren Schläfen. Halsschild nicht punktiert, ohne die kurzen Furchen, Grundskulptur deutlich und dicht, namentlich am Hinterleib viel stärker als bei der früheren Art. Färbung dieselbe. Länge, 3.2 bis 4 Millimeter. Vom selben Fundorte..... **E. parallelíceps sp. nov.**

Genus **THORACOCHIRUS** Bernhauer

1. Halsschild mit groben Nabelpunkten besetzt..... 4.
   Halsschild fein punktiert..... 2.
2. Halsschild sehr dicht punktiert, ohne Glanz. (Ich beziehe auf diese auf Luzon (Butao) gesammelte Art den mir in einem authentischen Stück bisher nicht vorgelegenen.)..... **T. raffrayi Fauvel.**[7]
   Halsschild nicht sehr dicht punktiert, glänzend..... 3.
3. Grösser, Kopf und Halsschild fein, letzterer ziemlich dicht punktiert, Flügeldecken grob gekörnt. Länge, 3.5 bis 4 Millimeter. LUZON, Pro-

[6] Ein Stück vom Mount Polis (Luzon) besitzt nur je einen Dorsalpunkt, ein klein wenig kürzere, nur im ersten Drittel bräunlichgelbe Flügeldecken, ohne dass ich dieses Tier für eine eigene Art ansprechen kann.

[7] Diese Art wurde auch auf Formosa von Sauter aufgefunden und von mir nach einem von Eppelsheim bestimmten Stück ursprünglich als *variolosus* Fauvel determiniert.

vinz Laguna, Mount Maquiling (*Baker*). MINDANAO, Subaan. MASBATE, Aroroy. SIARGAO (*Böttcher*). Sonst Mentawei. BORNEO.

T. nanus Heller.

Kleiner. Kopf und Halsschild sehr fein, letzteres sehr weitläufig punktiert, nach rückwärts nicht verengt mit einem deutlichen Zähnchen in den Hinterecken, Flügeldecken etwas kürzer, weniger grob und etwas weitläufiger, deutlich runzeliger gekörnt. Die kleinste, bisher bekannte Art. Länge, 2.3 bis 2.5 Millimeter. BILIRAN (*Böttcher*). Bisher zwei Stück bekannt..... **T. minutissimus** sp. nov.

4. Länge, 5 bis 6 Millimeter.

a^1. Halsschild sehr uneben, sehr grob und verhältnismässig dicht genabelt punktiert. MINDORO, Subaan. BILIRAN. (Stammform.)

T. variolosus Fauvel.[4]

a^2. Halsschild mit mehr oder minder ausgedehnten Spiegelflecken zwischen den Punkten.

b^1. Flügeldecken etwas kürzer als lang, grob gekörnt, häufig bräunlichgelb. BILIRAN (*Böttcher*). LUZON, Provinz Laguna, Mount Maquiling; Los Baños. SAMAR. BORNEO (*Baker*).

T. v. var. intermedius var. nov.

b^2. Flügeldecken so lang als breit, schwach gekörnt, Flügeldecken tiefschwarz. SUMATRA (*Förster*).

T. v. var. foersteri Bernhauer.

b^3. Halsschild grösstenteils glänzend glatt, eben, nur mit spärlichen Nabelpunkten besetzt, die sich meist an der Naht und hinter dem Vorderrande befinden. BILIRAN (*Böttcher*).

T. v. var. sublaevicollis var. nov.

Genus **PARALISPINUS** Bernhauer

Paralispinus exiguus Er. var. **obscuripennis** var. nov.

Diese Form unterscheidet sich von der einfarbig rötlichgelben Stammform durch schwärzliche Flügeldecken und bildet so den Uebergang zur einfärbig pechbraunen var. *piceus* Fauvel.

Subgenus **Clavilispinus** novum

Die neue Untergattung unterscheidet sich von den übrigen Arten sehr durch die plötzlich verdickten drei letzten Fühlerglieder, welche eine stark abgesetzte Fühlerkeule bilden.

Paralispinus (Clavilispinus) siargaoanus sp. nov.

Von *exiguus* Er. durch grössere Gestalt, viel längeren, nach rückwärts deutlich und geradlinig erweiterten Kopf, vorn gerade und sehr breit abgestutzten, in der Mitte eine kleine

[4] Es liegen eine grosse Zahl hierher gehöriger Stücke vor, welche ich nach der Beschreibung für den von Fauvel aus Ostindien beschriebenen *variolosus* halten muss. Die vorliegende Art variiert in einer solchen Weise dass man beim Vergleiche der extremsten Stücke unbedingt glauben müsste, man habe es mit mehreren Arten zu tun. Da jedoch alle möglichen Uebergänge zwischen den einzelnen Formen vorliegen, haben wir es hier nur mit einer äusserst veränderlichen Art zu tun.

Ausrandung zeigenden Clypeus, kleinere flachere Augen, viel längere Schläfen, die ganz anders gebildeten Fühler, längerer, an den Seiten geradlinigen, nach rückwärts schwach verengten Halsschild und den stärkeren Glanz des Vorderkörpers auf den ersten Blick zu unterscheiden. Kopf, Halsschild und Flügeldecken besitzen kaum eine wahrnehmbare Grundskulptur. Die Fühler sind sehr kurz, die Glieder vom vierten angefangen quer, das neunte, zehnte und elfte Glied stark erweitert, knopfförmig.

Die Färbung ist pechbraun, die Fühler, Beine und der Mund sind rostrot. Länge, 2.5 Millimeter.

SIARGAO, Dapa (*Böttcher*).

Genus HOLOSUS Motschulsky

1. Halsschild schmäler als die Flügeldecken, hinter der Mitte ausgeschweift. Punktierung grob ..... 2.
   Halsschild nicht oder kaum schmäler als die Flügeldecken, hinter der Mitte kaum ausgebuchtet. Punktierung fein oder fehlend ..... 5.
2. Flügeldecken länger als der Halsschild, dieser beträchtlich schmäler als die Flügeldecken ..... 3.
   Flügeldecken kürzer als der Halsschild, Körper kurz und breit, Kopf und Halsschild grob, ersterer sehr dicht, letzterer dicht punktiert, im Grunde glänzend ohne deutlich sichtbare Chagrinierung. Fühler kurz und dick, die vorletzten Glieder stark quer, um die Hälfte breiter als lang. Flügeldecken etwas feiner und weitläufiger punktiert, deutlicher chagriniert, ziemlich uneben. Halsschild wenig schmäler als die Decken, vor den Hinterecken flach eingedrückt, vor dem Schildchen nur unmerklich niedergedrückt. Hinterleib ziemlich matt chagriniert, nur mit sehr spärlichen und undeutlichen Schrägstrichen. Länge, 3.5 bis 4 Millimeter. MINDANAO, Provinz Surigao, Surigao (*Böttcher*) ..... **H. paradosus** sp. nov.
3. Halsschild ausser dem tiefen Längseindruck vor den Hinterecken ohne jeden Eindruck, eben, ohne erkennbare Grundskulptur, glänzend, Flügeldecken neben dem Nahtstreifen ohne schwielenartige Erhabenheit. Dem *foveolatus* Motschulsky sehr nahe stehend, von ihm durch viel breiteren und kürzeren Halsschild, schwächer ausgebuchtete Seiten und durch vollständiges Fehlen eines Eindruckes vor dem Schildchen, endlich durch kürzere, stärker und dichter punktierte Flügeldecken leicht zu unterscheiden. Länge, 4.5 Millimeter. MINDANAO, Provinz Lanao, Mumungan. Ein Exemplar.

   H. socius sp. nov.[1]

   Halsschild auch vor dem Schildchen mit je einem deutlichen Längseindruck, deutlich chagriniert, Flügeldecken neben dem Nahtstreifen mit einer schwielenartigen Erhabenheit ..... 4.

[1] Dieser Art täuschend ähnlich ist eine von Baker auf Borneo (Sandakan) in einem Exemplar erbeutete Art, die ich *cordicollis* sp. nov. benenne und die sich nur durch viel weitläufigere und feinere Punktierung des Kopfes, Halsschildes und der Flügeldecken unterscheidet.

4. Die Halsschildeindrücke vor dem Schildchen mässig tief, die schwielenartige Erhabenheit neben dem Nahtstreifen nur schwach erhaben, die Punktierung weniger kräftig und dicht. Länge, 3 bis 3.5 Millimeter. SIARGAO, Dapa. BUCAS, Socorro. DINAGAT. LUZON, Provinz Laguna, Mount Banahao; Mount Maquiling; Los Baños: Provinz Tayabas, Malinao: Provinz Nueva Vizcaya, Imugan. LUZON, Provinz Camarines Sur, Mount Isarog (*Baker, Böttcher*).
H. foveolatus Motschulsky.[10]

Die Halsschildeindrücke vor dem Schildchen sind sehr tief und gröber und dichter punktiert, die Schwiele neben dem Nahtstreifen stark erhoben und fast kielförmig, in der Mitte der Flügeldecken mit einem schwächeren, aber immerhin deutlichen Kiel, die Oberseite der Decken gröber und dichter punktiert, ziemlich uneben. Länge, 3 bis 4 Millimeter. PALAWAN, Binaluan (*Böttcher*). Sonst in Sumatra..... **H. plicatus Bernhauer.**

5. Körper gross, langgestreckt, ohne Spur einer Punktierung. Länge, 4 bis 5 Millimeter. LUZON, Provinz Nueva Vizcaya, Imugan (*Böttcher*). Sonst in Java..... **H. parcestriatus Fauvel.**

Körper kleiner, höchstens 3 bis 5 Millimeter lang..... 6.

6. Flügeldecken neben dem Schildchen mit einigen feinen Schrägstrichen, Körper weniger Kurz, Halsschild mässig quer, ungefähr ein Viertel breiter als lang. Länge, 3.5 Millimeter.... **H. philippinus Bernhauer.**

Flügeldecken ohne feine Schrägstriche neben dem Schildchen, Körper kurz, stark konisch verengt. Länge, 2 bis 3.2 Millimeter..... 7.

7. Halsschild mässig fein oder ziemlich kräftig punktiert..... 8.

Halsschild nicht oder nur sehr fein punktiert..... 12.

8. Flügeldecken kräftig oder ziemlich kräftig punktiert..... 9.

Flügeldecken sehr fein oder undeutlich punktiert..... 10.

9. Der Eindruck vor den Hinterecken des Halsschildes tief, verhältnismässig schmal, länger als breit, aussen kielförmig begrenzt, pechschwarz, glänzend, Fühler, Taster und Beine rostfarben, Kopf kräftiger und dichter, Halsschild kräftiger, Flügeldecken feiner und weitläufiger punktiert. Ganz vom Aussehen des *insularis* Fauvel jedoch von diesem durch die deutliche Punktierung der Flügeldecken und die tiefen Eindrücke vor den Halsschildecken leicht zu unterscheiden. Länge, 3 bis 3.5 Millimeter. PALAWAN, Binaluan (*Böttcher*) ..... **H. palawanensis sp. nov.**

Der Eindruck vor den Hinterecken des Halsschildes flach und breit, kaum länger als breit, aussen nur kantig begrenzt dunkel rostrot, glänzend, Kopf feiner und weitläufiger, Halsschild weniger stark, Flügeldecken viel stärker, scharf eingestochen punktiert, Flügeldecken etwas kürzer. Körper kleiner. Länge, 2.8 Millimeter (bei ausgezogenem Hinterleib). MINDORO, Subaan (*Böttcher*). Ein einzelnes Stück..... **H. boettcheri sp. nov.**

10. Flügeldecken viel länger als der Halsschild. Sehr stark glänzend kastanienbraun bis pechschwarz, Kopf und Halsschild deutlich, nicht allzu

[10] Ob diese Art wirklich *foveolatus* ist, kann ich mit vollster Sicherheit nicht angeben, da ich die Motschulsky'sche Art nur aus der Beschreibung kenne. Ich hielt die Art ursprünglich für eine Form des *mycetoporiformis* Motschulsky, welche jedoch keine mittleren Halsschildeindrücke besitzt.

stark, Flügeldecken undeutlich punktiert. Halsschild um ein Viertel breiter als lang, von vorn nach rückwärts in leichter Rundung erweitert, hinten am breitesten, in den Hinterecken breit und flach eingedrückt, Flügeldecken um ein Drittel länger als der Halsschild, Hinterleib stark glänzend, Grundskulptur kaum sichtbar, die Schrägstriche sehr fein. Länge, 3 bis 3.2 Millimeter, LUZON, Provinz Nueva Vizcaya, Imugan: Provinz Mountain, Balbalan. (*Böttcher*) ..... **H. luzonicus sp. nov.**

Flügeldecken nur wenig länger als der Halsschild ..... 11.

11. Halsschild in den Hinterecken mit einem ziemlich flachen breiten Eindruck, Punktierung etwas feiner, die Schrägstriche auf dem Hinterleib undeutlich, kleiner. Farbe gelb (vielleicht unreif?). Länge 2.2 Millimeter. MINDANAO, Provinz Surigao, Surigao (*Böttcher*). Ein Stück ..... **H. pallidus sp. nov.**

Halsschild in den Hinterecken mit einem tiefen schmäleren Eindruck. Punktierung etwas stärker, die Schräglinien am Hinterleib schärfer eingeritzt, deutlich. Körper etwas grösser. Färbung des ausgereiften Tieres dunkel pechfarben mit helleren Beinen. Länge, 3 Millimeter. LUZON, Provinz Laguna, Los Baños (*Böttcher*). Ein Exemplar ..... **H. piceolus sp. nov.**

12. Färbung rötlichgelb bis rostrot, kaum oder undeutlich punktiert. Kopf ohne Grübchen ..... 13.

Färbung pechfarben, ganz von der Färbung und Gestalt des *insularis* Fauvel, jedoch durch wesentlich feinere und weitläufigere Punktierung des Halsschildes, das Vorhandensein von zwei mehr oder minder deutlichen Grübchen neben den Fühlereinlenkungsstellen, nicht oder nur sehr undeutlich punktierten Kopf, tiefere Eindrücke in den Hinterwinkeln des Halsschildes und kleinere Gestalt verschieden. Länge, 2 bis 2.3 Millimeter. MASBATE, Aroroy. SIARGAO, Dapa. LEYTE. LUZON, Provinz Laguna, Los Baños (*Böttcher*).

H. bifoveolatus sp. nov.

13. Grösser, Färbung rostrot, Halsschild und Flügeldecken bei allerschärfster Lupenvergrösserung äusserst zart, wie ein Hauch, aber immerhin wahrnehmbar punktiert, die Eindrücke in den Halsschildhinterecken beträchtlich stärker, die Fühler mässig kurz, die vorletzten Glieder kaum mehr als um die Hälfte breiter als lang. Länge, 3 Millimeter. SIARGAO, Dapa (*Böttcher*) ..... **H. ferrugineus sp. nov.**

Kleiner, Färbung rötlichgelb. Halsschild spiegelglänzend, ohne wahrnehmbare Punktierung, Flügeldecken fein gerunzelt, weniger glänzend, die Halsschildeindrücke flacher, die Fühler sehr kurz, die vorletzten Fühlerglieder mehr als doppelt so breit als lang. Länge, 1.8 bis 2 Millimeter. LUZON, Provinz Camarines Sur, Mount Isarog. MINDORO, Subaan (*Böttcher*) ..... **H. rufotestaceus sp. nov.**

Genus **PSEUDOLISPINODES** novum

Körper gestreckt, mässig gewölbt. Kopf viel schmäler als der Halsschild, hinten nicht abgeschnürt, mit ziemlich kleinen, flachen, kaum vorstehenden Augen. Fühler kurz, die drei ersten Glieder länger als breit, die folgenden bis zum zehnten quer,

allmählich an Breite zunehmend, die vorletzten stark quer, das letzte fast eiförmig. Mandibeln kurz, dick, die eine hinter der Spitze mit einem stumpf verrundeten Zahn, hinter diesem mit einer Anzahl langer, dicht stehender Haare, die andere ohne Zahn, mit Ausnahme der Spitze lang behaart. Die Innenlade der Maxillen an der Spitze mit zwei hintereinander stehenden hakenförmigen Zähnen besetzt, hinter diesen an der abgestutzten Spitze dicht behaart, am Innenrande häutig, die Aussenlade sehr breit ähnlich wie bei *Holosus*. Auch die Kiefertaster sind denen der genannten Gattung recht ähnlich, das Endglied stark verlängert. Das Kinn ist in der Form dem der Gattung *Holosus* recht ähnlich, ebenso die Zunge sammt den Paraglossen, die zwei Zungenlappen jedoch weiter vorgestreckt, an einander stehend. Die Lippentaster sind etwas kürzer, das Endglied nur doppelt so lang als das zweite. Halsschild herzförmig, schmäler als die Flügeldecken, diese langgestreckt, am Rücken mit einer von der Schulter beginnenden, fast bis zum Hinterrande reichenden scharfen Längsfurche. Hinterleib ungerandet, an der Wurzel der vorderen Ringe abgeschnürt, Schrägstriche mehr oder minder deutlich.

Tarsen vier- oder fünfgliedrig [11] die Vorder- und Mitteltarsen in der Apikalpartie aussen mit kurzen dicken Dornen bewehrt, die Hintertarsen besitzen in der Apikalpartie eine Reihe von ungefähr neun langen, dicken, etwas gekrümmten, dicht stehenden Stacheln.

Die neue Gattung steht dem *Holosus* Motschulsky gewiss am nächsten, unterscheidet sich ausser einzelnen Details sofort durch die Bedornung der Beine. Durch dieses Merkmal sowie durch die Tarsenzahl ist sie von *Lispinodes* Sharp ebenfalls sicher zu unterscheiden.

Uebersicht der Pseudolispinodes-Arten

1. Halsschild viel schmäler als die Flügeldecken, diese sehr gross, um die Hälfte länger als der erstere, viel länger als zusammen breit. Halsschild kräftig und nicht zu weitläufig punktiert, Flügeldecken dicht chagriniert, wenig glänzend, Färbung pechschwarz mit helleren Fühlern und Beinen. Länge, 2.1 bis 2.5 Millimeter. LUZON, Provinz Mountain, Mount Polis (*Böttcher*) ..... P. longipennis sp. nov.
Halsschild nur mässig schmäler als die Flügeldecken, diese mässig gross, höchstens um ein Drittel länger als der erstere ..... 2.

[11] Die Zählung der Tarsenglieder bei diesem Genus ist recht schwierig, da an der Stelle des ersten Gliedes die Bedornung der Schienenspitze kein klares Bild dieses Gliedes ergibt.

2. Halsschild kräftig und ziemlich dicht punktiert. Ostindien.
P. madurensis Bernhauer.

Halsschild kaum und nur weitläufig punktiert..... 3.

3. Körper grösser, breiter, glänzend, die Chagrinierung weitläufig, Halsschild nur bei stärkster Lupenvergrösserung äusserst zart punktiert. Flügeldecken kaum länger als breit, nicht punktiert. Länge, 2.2 Millimeter. LUZON, Provinz Nueva Vizcaya, Imugan (*Böttcher*). Ein einziges Stück..... **P. latiusculus sp. nov.**

Körper kleiner, schlanker, Flügeldecken um ein gutes Stück länger als der Halsschild. Eine sehr veränderliche Art. Die Färbung variiert vom dunklen pechschwarz bis zum lichten bräunlichrot oder gar bräunlichgelb. Die Gestalt ist bald sehr schlank, bald etwas robuster, die Flügeldecken sind meist nur ein Viertel, häufig jedoch fast um ein Drittel länger als der Halsschild; die Punktierung des Halsschildes ist bei der gewöhnlichen Form sehr fein, häufig jedoch stärker und deutlicher sichtbar. Bei einer Form ist diese Punktierung besonders kräftig und dichter, die Flügeldecken gut um ein Drittel länger als der Halsschild, zugleich ist der Halsschild und die Flügeldecken mehr oder minder lichter gelb (var. *puncticollis* m.). Flügeldecken in der Regel nicht oder undeutlich punktiert, bisweilen ist die Punktierung jedoch deutlich (var. *punctipennis* m.). Die Verschiedenheit der extremsten Formen ist eine solche, dass man versucht wäre spezifisch verschiedene Arten anzunehmen. Es ist mir jedoch vorläufig nicht gelungen eine Artverschiedenheit festzustellen, da alle Uebergänge vorliegen. Länge, 1.5 Millimeter. Ueber die Philippinen weit verbreitet; sonst noch von Mentawei bekannt..... **P. sinuatus** Bernhauer.

Genus **THORACOPHORUS** Motschulsky

1. Körper sehr klein und schmal. Länge, 1.2 bis 1.5 Millimeter..... 4.
Körper grösser und robuster, über 1.5 Millimeter lang..... 2.

2. Kurz, dick, Flügeldecken zusammengenommen viel breiter als lang, Hinterleib auf den vorderen Tergiten äusserst dicht, gleichmässig gerunzelt, in den Querfurchen nur sehr fein punktiert. Länge, 2 Millimeter. LUZON, Provinz Bataan, Limay. Ein Stück.
P. brevicristatus var. deletus Fauvel.

Gestreckter, Flügeldecken zusammengenommen nicht oder nur wenig breiter als lang, Hinterleib auf den vorderen Tergiten ausser der matten Grundskulptur mit einer Anzahl von Längsfältchen, in den basalen Querfurchen kräftig, gleichsam gekerbt punktiert..... 3.

3. Flügeldecken sehr lang, um ein gutes Stück länger als zusammen breit, um die Hälfte länger als der Halsschild, dieser an den Seiten gerade, die innere Rippe auf den Flügeldecken kaum weniger kräftig als die übrigen, die Naht bei gewisser Ansicht deutlich kielförmig; Färbung dunkel rötlichbraun mit helleren Fühlern und Beinen. Länge, 1.5 Millimeter. LUZON, Provinz Nueva Vizcaya, Imugan. CATANDUANES, Virac (*Böttcher*)..... **P. longipennis sp. nov.**

Flügeldecken mässig lang, nur so lang als zusammen breit. Länge, 1.5 bis 1.7 Millimeter. LUZON, Provinz Laguna, Los Baños; Provinz

Nueva Vizcaya, Imugan (*Baker, Böttcher*). MINDORO, San Teodoro. SIARGAO, Dapa. In Anzahl gefangen..... P. philippinus sp. nov.[12]

4. Matt rötlichgelb. Kopf vorn mit zwei Grübchen, ohne Andeutung von Längsrippen, hinten mit zwei ocellenähnlichen Beulchen, Fühler sehr kurz, die vorletzten Glieder doppelt so breit als lang, Halsschild wenig länger als breit, an den Seiten bis zum letzten Drittel gleichbreit ohne spitzige Zähnchen, auf der Scheibe ohne Längsrippen, vorn mit einem breiten, rückwärts mit zwei rundlichen tiefen Gruben, an den Seiten rückwarts mit einem tiefen Längseindruck, wie der übrige Körper matt chagriniert. Flügeldecken viel länger als der Halsschild, länger als zusammen breit, die Innenrippe kaum, die übrigen schwach angedeutet, schwach seidig schimmernd. LUZON, Provinz Ilocos Norte, Bangui (*Böttcher*).....P. minutissimus sp. nov.[13]

Genus ESPESON Schaufuss

1. Körper sehr klein, sehr schmal, Flügeldecken fast doppelt so lang als der Halsschild, dieser so lang als breit, an den Seiten nicht gezähnelt, beiderseits der Mittellinie mit einem langen, tiefen Längseindruck, Kopf fast breiter als der Halsschild, rundlich, grob und verhältnismässig dicht punktiert, die Augen flach, nicht vorstehend, hinter ihnen mit wohlentwickelten Schläfen, die Fühler kurz, die vorletzten Glieder stark quer, das siebente nur mässig grösser als die einschliessenden, Flügeldecken mit einer Humeralreihe kräftiger Punkte, Hinterleib chagriniert, die einzelnen Tergite neben der Mittellinie mit einem deutlichen Eindruck..... Parespeson subg. nov.

Rötlichgelb, sehr stark glänzend, der Hinterleib seidig glänzend. Länge, 1.2 Millimeter. LUZON, Provinz Ilocos Norte, Bangui (*Böttcher*).

E. angustissimus sp. nov.

[12] Eine etwas veränderliche Art. Die Färbung der meisten Stücke ist bräunlichrot, es kommen jedoch auch dunklere, öfters auch ganz braunschwarze Stücke vor. Die Halsschildseiten sind bei der häufigen Form fast gerade, das Zähnchen hinter der Mitte spitzig, der Halsschild ist gewöhnlich um ein Drittel breiter als lang, die Innenrippe auf den Flügeldecken ist etwas schwächer entwickelt, so dass sie bei gewisser Ansicht nicht sichtbar ist. Es gibt jedoch Stücke, die sich durch etwas weniger kurzen, an den Seiten mehr oder minder gerundeten Halsschild, stumpfes Seitenzähnchen, stärkere Innenrippe der Decke und braunschwarze Färbung auszeichnen und zugleich etwas kräftiger und plumper gebaut sind (ab. *obscurior* m. von Butao, Mount Banahao, auf Luzon). Da jedoch einige Stücke vorhanden sind, welche Merkmale beider Formen besitzen, und eine scharfe Trennung nicht möglich ist, bin ich der Meinung, dass wir es hier nur mit immerhin bemerkenswerten Abarten einer und derselben Art zu tun haben.

[13] Die Art steht dem *Thoracophorus alluaudi* Fauvel von den Seychellen ungemein nahe und unterscheidet sich von ihr nur durch halb so geringe Grösse, schmäleren Kopf, mehr gleichbreite Seiten des Halsschildes und kaum angedeutete Innenrippe der Flügeldecken. Beide Arten zeichnen sich durch das Fehlen der Rippen auf dem Halsschild aus, weshalb für diese Arten das neue Subgenus *Leipophorus* aufgestellt sei.

Körper grösser, breiter und kürzer, Flügeldecken nur wenig oder mässig länger als der Halsschild, dieser stark quer, an den Seiten gezähnelt, Kopf kaum so breit als der Halsschild, spärlich punktiert, das siebente Fühlerglied viel breiter als die einschliessenden, die Flügeldecken überall weitläufig punktiert. Hinterleib ohne die Eindrücke zu beiden Seiten der Mittellinie (*Espeson* s. str.) ..... 2.

2. Augen nicht vorstehend, flach, Schläfen deutlich hinter den Augen entwickelt, Kopf nach rückwärts deutlich erweitert, kräftig und ziemlich weitläufig punktiert. Halsschild schwach quer, um ein Viertel breiter als lang, Flügeldecken um ein Drittel länger als der Halsschild, etwas länger als zusammen breit, wie dieser kräftig und weitläufig punktiert. Färbung rostrot bis rostgelb mit meist etwas dunkleren Fühlern und helleren Beinen. Länge, 1.8 bis 2.3 Millimeter. LUZON, Provinz Laguna, Los Baños. SIARGAO, Dapa. MASBATE, Aroroy. DINAGAT. MINDANAO, Provinz Lanao, Mumungan..... **E. philippinus sp. nov.**[11]

Augen stark vorstehend, gewölbt, Schläfen fehlend, der Kopf unmittelbar hinter den Augen abgeschnürt, Halsschild stark quer, Flügeldecken nur mässig länger als der Halsschild, quadratisch..... 3.

3. Körper kleiner, schlanker, Halsschild weniger kurz und breit, fast um ein Drittel breiter als lang, um ein gutes Stück schmäler als die Flügeldecken, Punktierung ziemlich kräftig. Rostrot glänzend. Länge 1.8 bis 2 Millimeter. POLILLO (*Böttcher*).. **E. indomalayensis sp. nov.**

Körper grösser, breiter und robuster, Halsschild kurz und breit, um die Hälfte breiter als lang, wenig schmäler als die Flügeldecken, Punktierung im allgemeinen ziemlich fein. Rostrot, glänzend. Länge, 2.2 bis 2.5 Millimeter. LUZON, Provinz Nueva Vizcaya, Imugan (*Böttcher*) ..... **E. luzonicus sp. nov.**

Genus **TETRAPLEURUS** Bernhauer

1. Flügeldecken mit deutlichen Rippen..... 2.

Flügeldecken mit nur angedeuteten, sehr undeutlichen Rippen, vollkommen matt..... 4.

2. Körper stark glänzend..... 3.

Körper matt, der Hinterleib etwas glänzend, die Flügeldecken bisweilen mit schwach seidigem Schimmer. Bräunlichgelb bis rostrot, die Beine etwas heller, Kopf und Halsschild äusserst dicht gerunzelt-chagriniert, vollständig matt, der Kopf mit zwei Stirngrübchen, am Scheitel mit zwei kleinen, ocellenähnlichen Beulen. Fühler kurz, die vorletzten Glieder stark quer. Halsschild viel kürzer als bei *indicus* Bernhauer, mit ähnlichen Eindrücken, die Mittelfurche fein und durchgehend. Flügeldecken viel kürzer, jedoch immerhin fast um die Hälfte länger als der Halsschild, die Rippen breit, flach, nicht sehr scharf ausgeprägt, die ganze Oberfläche einschliesslich der Rippen äusserst fein chagriniert, nicht oder nur sehr schwach glänzend. Länge, 1.8 bis 2 Millimeter. LUZON, Provinz Laguna, Mount Maquiling (*Baker*); Los Baños, Februar, 1914; Mount Banahao: Provinz Mountain, Balbalan. MINDANAO, Provinz Surigao, Surigao (*Böttcher*)... **T. bakeri sp. nov.**

[11] Fünf Stücke von Dapa besitzen kürzere, den Halsschild nur den vierten Teil übertreffende Flügeldecken und kürzeren Halsschild (var. *curtus* m.), ohne das ich bisher die Ueberzeugung vom Bestande einer eigenen Art gewinnen konnte.

3. Breit, Halsschild fast um die Hälfte breiter als lang, Gestalt und Grösse des *bakeri*, durch den starken Glanz des Körpers sofort zu unterscheiden. Ausserdem von ihm durch tiefere Stirngrübchen, zwischen diesen sehr stark erhobene Stirn, tiefere, breitere Halsschildmittelfurche und das Vorhandensein von vier quergestellten glänzenden Beulen vor der Basalfurche und zwei ebensolchen am Hinterrande gegen die Hinterecken zu, durch stärker entwickelte Rippen auf den Flügeldecken und viel schwächer skulptierten Hinterleib verschieden. Länge, 1.8 Millimeter. MINDANAO, Provinz Lanao, Mumungan (*Böttcher*). Ein Stück..... **T. banghaasi sp. nov.**

Schmal, Halsschild nur um ein Viertel breiter als lang, rostrot, stark glänzend. Kopf klein, fast so lang als breit vorn mit zwei Stirngrübchen und daneben mit grossen spiegelglänzenden Fühlerhöckern, hinten kräftig und ziemlich dicht punktiert, ohne Grundskulptur. Fühler mässig kurz, die vorletzten Glieder ungefähr um die Hälfte breiter als lang. Halsschild nur wenig schmäler als die Flügeldecken, an den Seiten ziemlich gleichmässig gerundet, vor dem Hinterrande mit der normalen starken Querfurche, innerhalb der Hinter- und Vorderecken mit je einem starken Längsgrübchen, vor der Mitte des Vorderrandes mit einer kurzen tiefen Längsfurche, zu deren Seite mit je einem Punktgrübchen, hinter diesem mit einem grösseren Grübchen, von welchem einige kräftige Punkte nach rückwärts gegen die Mittellinie zu streichen, die Mitte des Seitenrandes ist in eine glänzende Beule erhoben, neben welcher sich eine grössere befindet. Flügeldecken wenig länger als der Halsschild, regelmässig quadratisch, die Rippen mässig erhoben, die Zwischenräume stark und dicht punktiert. Hinterleib chagriniert, weniger glänzend als der Vorderkörper. Länge, 2.2 Millimeter. PALAWAN, Binaluan (*Böttcher.*) Zwei Stücke..... **T. splendidus sp. nov.**

4. Rötlichgelb, kurz, Halsschild um die Hälfte breiter als lang, ganz von der Gestalt des *bakeri* m., von diesem durch die fast erloschenen, nur sehr undeutlich angedeuteten Rippen der Flügeldecken, den Mangel der feinen Mittelfurche des Halsschildes und das Vorhandensein eines deutlichen Grübchens vor den Vorderecken leicht zu unterscheiden. Länge, 2 Millimeter. LUZON, Provinz Laguna, Los Baños, Februar, 1914 (*Böttcher*). Ein einziges Stück..... **T. banosanus sp. nov.**

Schwarz, gestreckter, Halsschild um ein Drittel breiter als lang, wenig uneben, die basale Querfurche nur schwach angedeutet, die Grübchen in den Hinterecken mässig tief, sonst kaum eingedrückt, so wie der Kopf und die Flügeldecken äusserst dicht runzelig chagriniert, ohne jeden Glanz. Fühler mässig kurz, die vorletzten Glieder ungefähr um die Hälfte breiter als lang. Flügeldecken um die Häfte länger als der Halsschild, quadratisch, die Rippen äusserst schwach angedeutet. Hinterleib fein punktiert-gerunzelt, etwas glänzend. Länge, 2 Millimeter. LUZON, vom selben Fundorte (*Böttcher*). Zwei Stücke.

T. opacus sp. nov.[*]

[*] *Lispinodes heteroderes* Fauvel, *rugosus* Fauvel, und *seriatus* Fauvel, Rev. d'Ent. (1902) 30, 31, gehören nach der Beschreibung zweifellos nicht in die Gattung *Lispinodes* Sharp, welche dreigliedrige Tarsen besitzt, sondern in das vorstehende Genus, lassen sich aber mit keiner der philippinischen Arten identifizieren.